DELHI POLYTECHNIC
LIBRARY

CLASS NO.

BOOK NO.

ACCESSION NO.

MGIPC—S5—XVI 17—11-1-49—2,000.

MANUFACTURE OF SOAP

A Manual revealing the Art of Soap Manufacture
from the Theoretical and Practical points of
view with lots of Tried Recipes for making
Washing, Toilet, Medicated and
other forms of Special Soaps.

BY

AN INDUSTRIALIST

TENTH EDITION

(All Rights Reserved)

INDUSTRY PUBLISHERS LTD.,
Keshub Bhaban,
22, R. G. KAR ROAD, SHAMBAZAR, CALCUTTA.

1946

LIST OF ILLUSTRATIONS

Fig. 1. Section of a Soap Kettle - - - - 60
„ *2.* Soap Boiler for Direct Steam Heating 60
„ *3.* Soap Frames with Screw Clamps - 62
„ *4.* Soap Frame - - - - - - - - 60
„ *5.* Soap Cutting Machine - - - - 65
„ *6.* Slabbing Machine - - - - - 65
„ *7.* Barring Machine - - - - - - 65
„ *8.* Soap Stamping Machine - - - - 67
„ *9.* Soap Dies - - - - - - - - 68
„ *10.* Automatic Soap Press - - - - 68
„ *11.* Soap Chipping Machine - - - - 70
„ *12.* Soap Drying Chamber - - - - 70
„ *13.* Soap Rubbing Machine - - - - 72
„ *14.* Screw Plodder - - - - - - - 72
„ *15.* Section of Screw Plodder - - - - 73
„ *16.* View of Washing Soap Factory - - 99
„ *17.* Multiple Soap Roller - - - - - 129
„ *18.* View of Toilet Soap Factory - - 130

CONTENTS

PAGE

CHAPTER I.

INTRODUCTION.

The Significance of Soap 1
Detergent Action of Soap 2
Varieties of Soap ... 2
Hard and Soft Soap .. 3
Consistency of Soaps .. 3
Applications of Soaps .. 4
Chief varieties of Soap .. 5

CHAPTER II.

RAW MATERIALS IN SOAP MAKING.

Tallow . 8
Lard 10
Coconut Oil ... 11
Palm Oil . 12
Cotton Seed Oil 13
Linseed Oil . 14
Castor Oil ... 15
Groundnut Oil . 16
Mahua Oil . . 16
Sesamum Oil . 17
Fish Oil . 17
Other Oils .. 18
Neem Oil 18
Rayna Oil . 19
Karanja Oil . 20
Punnal Oil . . 21
Safflower Oil . . 22
Chaulmoogra Oil .. 22
Caustic Soda . . 23
Caustic Potash ... 25
Sodium Carbonate ... 26
Carbonate of Potash ... 27
Salt ... 27
Rosin ... 28
Filling Agents ... 29
Sodium Silicate ... 29
Starch ... 30
Glauber's Salt ... 30
Soap Stone 30
Pearl Ash ... 31
Borax . 31
Soap Perfumes . 31
Natural Perfumes ... 32
Synthetic Perfumes .. 34
Fixatives . 35
Soap Colours ... 35

CHAPTER III.

PRINCIPLES OF SOAP MANUFACTURE.

Saponification 37
What is Soap . 38
How Saponification Proceeds 38
Modes of Manufacture . 39
Cold Process Soaps 40
Determination of Caustic Soda Required . . 41
Procedure . 42
Semi-Boiling Process . 43
Boiling Process .. 44
Testing for Saponification 45
Graining Out or Salting Out .. 46
Cleaning the Soap ... 47
Boiling on Strength ... 48
Fitting ... 49
Setting ... 49
Modified Boiling Process 50
Advantages of the Method 52
Utilisation of Salted Lye .. 53
Using the Silicate of Soda 54
Using Soda Ash ... 55
Hardness of Soaps ... 56

PAGE

CHAPTER IV

FACTORY EQUIPMENTS.

Furnace ... 58
Soap Kettles 59
Soap Frames 61
Slabbing Machine 64
Barring Machines 64
Stamping Machines 66
Chipping Machine for Soap Bars 69
Soap Drying Machines 69
Soap Mixer 69
Soap Crusher 91
Squeezing Machine (Screw Plodder) 71
Disintegrators 73
Appliances 73

CHAPTER V

PRELIMINARY OPERATIONS IN SOAP MAKING

Softening Water 74
Refining of Tallow 74
Necessity for Refining Oil 77
Purification of Oils and Fats 78
Purification with Water 78
Recovery of Oil from Emulsified Layer 79
Purification with spent Lye 80
Purification with Caustic Soda 80
Bleaching the Oil 81
Deodorising the Oil 81
Making Caustic Lye 82
Concentration of the Lye 85
Relation between Specific Gravity, Degrees Beaume and Twaddle ... 81
Caustic Soda Lye 86
Table of Specific Gravities of Solutions of Caustic Soda 87
Explanation of the Table 89

PAGE

Caustic Potash Lye 90
Table of Strength of Caustic Potash Solution at 60°F 91
Making Soda Ash Solution 91
Table of Specific Gravity of Sodium Carbonate 92
Making Salt Solution 92
Table of Specific Gravity of Common Salt Solution at 15°C 93
Soap Stock 93
Crutching 94
Liquoring of Soaps 94
Remelting 95
Neutralising 95
Framing 95
Slabbing and Barring 96
Piling 96
Drying 96
Stamping 96

CHAPTER VI

WASHING SOAP.

Soap Stock 98
Caustic Soda 100
Soap by Cold Process 101
Recipes (12) 101
Soap by Semi Boiling Process 108
Recipes (10) 108
Soap by Boiling Process 110
Recipes (2) 110
Pot Moulded Soap 110
Grained or Dhobi Soap 112
Framing 113
Stamping 114
Improved Method of Making Grained Soap 115
Pale Soaps 116
Method of Using Rosin 117
Hardening Pale Soap 118
Recipes (5) 119
Treatment of Waste Soap 121
Treatment of Niger 122
Rectifying Soap Batch 122

PAGE

CHAPTER VII.

TOILET SOAP.

Characteristics of a Toilet Soap 123
Toilet Soap by Cold Process 124
Windsor Soap 125
Brown Windsor Soap 125
Almond Soap 126
Rose Soap 126
Lemon Soap 126
Violet Soap 126
Orange Soap 126
Toilet Soap by Remelting 127
Bouquet Soap 127
Santal Soap 127
Heliotrope Soap 127
Almond Soap 128
Windsor Soap 128
Milled Soap 128
General Method 129
Bouquet Soap 132
Santal Soap 132
Citron Soap 133
Rose Soap 133
Millefluer Soap 133
Musk Soap 133
Elder Flower Soap 132
Lily Soap 134
Glycerine Soap 134

CHAPTER VIII

TRANSPARENT SOAPS.

Recipes (6) . 138
Glycerine Soap 139
Recipes (4) 139

CHAPTER IX

SOAP POWDER

[illegible]ufacture of Soap Powder 142
Mixing and Framing 142
Grinding Soap Powder 143
Packing Powder 144
Recipes (8) 144

PAGE

Shaving Powder 146

CHAPTER X.

LIQUID SOAPS.

Recipes (2) 148
Liquid Toilet Soap 149
Liquid Glycerine Soap (3) 149

CHAPTER XI

FLOATING SOAPS.

Framing . 152
Recipes (5) 152

CHAPTER XII.

MOTTLED SOAP.

General Method of Manufacture .. 156
Two Kinds 157
Blue Mottled Soap 158
Grey Mottle 159
Red Mottle 159

CHAPTER XIII.

SOFT-SOAPS.

Method of Manufacture . 160
Pro-cess of Saponification 162
Typical Soap Charges 163
Equipment and Manufacturing Cost of Soft Soap 164
Recipes (3) ... 165

CHAPTER XIV.

MEDICATED SOAPS.

Stock Soap 167
Soaps for Skin Diseases 168
Carbolic Soaps (4) 168
Neem Soaps . 170
Chaulmugra Soap (4) 170
Cresol Soap .. 172
Naphthalene Soap .. 172
Naphthol Soap .. 172

PAGE
Camphor Soap .. 173
Borax Soap ... 173
Iodine Soap .. 174
Mercurial Soap .. 174
Sulphur Soap (2) .. 174
Tooth Soap 175
Coal Tar Soaps 175
Tar Sulphur Soaps (3) 176
Wood Tar Soap 176
Thymol Soap (2) 177
Tannin Soap .. 178
Menthol Soap .. 178
Formaldehyde Soap 178
Germicidal Soap 178
Surgical Soap 178

CHAPTER XV

SHAVING SOAPS

Recipes (5) 179
White Shaving Soap .. 181
Shaving Soap Powder 181

CHAPTER XVI.

TEXTILE SOAPS.

Wool Soaps 183
Calico Printers' Soap .. 183
Silk Soap .. 184
Silk Soap 184
Dyers' Soap .. 184
Monople Soap .. 184
Castor Oil Soap for Para Red 185
Marseilles Soap .. 185
Dye Soap (2) .. 186
Cotton Printers' Soap 186
Dry Cleaning Soap (3) .. 186

CHAPTER XVII

MISCELLANEOUS SOAPS.

PAGE
Metal Polishing Soap ... 188
Petroleum or Paraffin Soaps .. 188
Depilatory Soap (2) 188
Saddle Soap (2) 189
Dog Soap (2) ... 189
Liquid Dog Soap .. 190
Stain Removing Soap 190
Scouring Soap and Powder 190
Peroxide Soap .. 191
Castile Soap 192
Curd Soap 192
Marine Soap (3) 193
Sand Soap (2) 194
Vaseline Soap .. 195
Tannin Soap .. 195
Carpet Soap ... 195
Oatmeal Soap 195
Honey Soap 195
Fleece Washing Soap .. 195
Silex Soap 195
Molasses Soap 196
Soap Paper ... 196
Soaps Containing Chlorinated Hydrocarbon 196
Liquid Dental Soap 197
Rug Cleaners' Soap .. 197

CHAPTER XVIII

ANALYSIS OF SOAP.

Determination of Fatty Acids 198
Determination of Silicate 199
Determination of Free Alkali 199
Determination of Free Fat 200
Detection of Resin 201
Determination of Water in Soap .. 201
Determination of Carbolic Acid [illegible]
Determination of Sodium Chloride ... [illegible]

CHAPTER I.

INTRODUCTION.

THE use of soap in some form or other may be traced to very ancient times. With the dawn of civilization man had been on the lookout for a substance which would help him in scouring his garments, and the outcome of his investigations is the soap. It marks a great improvement over the primitive pot ashes obtained by burning certain plants, or over the vegetable, mineral and chemical substances like soap nuts, fullers' earth, soda, infusorial earths, etc., but still it is far from being perfect.

THE SIGNIFICANCE OF SOAP.

The word *soap* is derived from the latin word *sapo*, meaning tallow. It leads us to the view that in the European countries the tallow and greases mixed with pot ashes formed the starting point in the manufacture of soap. But now-a-days the meaning of the word *soap* has been extended to include the products obtained from various fats and oils.

We are all familiar with soaps, and know the chief purposes they perform but to give a definition of the term is very hazardous and fraught with technical difficulties. Definitions have been attempted, based on properties and chemical composition of soaps. Popularly speaking, soap is an "alkaline or unctuous substance used in washing and cleaning." In its strictly chemical sense it refers to "some combinations of fatty acids with caustic alkalies which on treatment with water liberate alkali, so very helpful in scouring."

DETERGENT ACTION OF SOAP.

One of the most important properties of soap is the removal of fatty impurities and the abstraction of dirt from various kinds of textiles without injuring the materials. An explanation of this detergent action of the soap has been sought for by many scientists. The commonly accepted view is that when the soap is dissolved in water a small quantity of alkali is set free. It is this free alkali that attacks any greasy matter on the surface of the material to be cleansed and dissolves it. This loosens the dirt particles adhering to the fat and renders them easily washable.

Exhaustive researches, however, have shown that the explanation given above is faulty. Modern scientists have based their explanations on the emulsifying power of soap solutions. Coming in contact with water, the soap gets *hydrolysed, i.e.*, it is broken up into a fatty acid and a base. The emulsion wets and penetrates into oily textures and is capable of entering into a colloidal combination with dirt that adheres to the oil. This consequently removes the dirt, and the soap itself is carried away when washed in water. Still others attribute the detergent action of the soap solution to its property of lubricating the texture and the impurities, thus promoting their removal. Another view is that the alkali liberated by the action of water on soap helps the contact of the water with the dirty substance and thus greatly facilitates the washing operation.

VARIETIES OF SOAP.

Various kinds of raw materials enter into the composition of the soap; even the same material is available in multifarious grades. Hence the properties of the soap exhibit distinct variations according to the nature of the raw materials used. Attempts have been made to classify soap chiefly under two broad headings, viz., *hard soap* and *soft soap*.

HARD AND SOFT SOAP.

Soaps which dissolve very moderately in water and cannot be easily rubbed on the surface of the substance to be cleaned are technically known as *hard soaps*. They do not give lather freely, and being only partially soluble it takes much time and labour to scour a dirty material with these soaps and even then the substance treated is only partially or imperfectly cleansed.

The soft soaps, in the other hand, dissolve readily in water, give free lather but they are rather wasteful in use.

CONSISTENCY OF SOAP.

Hardness or *softness* of soaps depends chiefly upon the alkali used. Soaps made with caustic soda are generally harder than those made with caustic potash. As a general rule the sodium soaps made from fats or mixtures of semi or non-drying oils are hard soaps as distinguished from the potash compounds of the drying oils which are commonly distinguished as soft soaps.

Hardness or *softness* of soap has also much to do with the ingredients other than the alkali. Consistency of a soap varies with the composition of the oil and fat from which it is made and also with the various filling agents employed. Usually tallow, animal fats and coconut oil produce a hard soap having a firm texture while the soaps obtained from linseed oil and castor oil are soft in texture. Again there are oils which yield soaps which can neither be classed as hard nor soft, e.g., mahua, groundnut oil, etc. The filling agents generally lend a firm body to the soap.

Hence while making soaps careful attention needs be paid to the selection of the soap stock. Neither hard nor soft soaps can find favour with the common customers. They would like to have, on the other hand, a soap which combines in one all the good properties that a soap can claim. The art of a soap manufacturer consists in blending the various hard soap making and soft soap making elements and the filling agents in proper proportions so that the finished product may be of a quite stisfactory consistency and quality.

APPLICATION OF SOAPS.

Besides these two broad sub-divisions there are many varieties of soaps, which serve diverse purposes. There is first the *domestic soap* which is largely requisitioned for laundry purposes ; the washermen as a class consume a great quantity of *laundry* soaps which are generally a bit inferior to the domestic soaps in properties. Then there is the *toilet soap* which is necessary for cleansing the person. There was a time when the use of toilet soaps was considered by the masses as a luxury which they could ill afford to indulge in large quantities. But toilet soaps have now-a-days met wider popularity. Then there are *industrial soaps* required for scouring purposes in the dyeing, woollen, silk and calico industries. In factories *cheap soap* and *liquid soap* are consumed in huge quantities to wash off the hands and cleanse the floor and sundries. Special soaps, called *marine soaps*, are in demand for use in ships to be used with salt water. There is another class of soaps known as *medicated soaps*. These include a wide range of articles such as carbolic soap, margosa soap, coal-tar soap, naphthol soap, camphor soap, sulphur soap, etc., etc.

CHIEF VARIETIES OF SOAPS.

Apart from these classifications there is another broad way of classifying the soaps based on their process of manufacture.

Bar Soaps are pale yellow laundry soaps generally obtained by the process of settling and then finished in the shape of bars. These were much in demand during the pre-war days but they have now fallen into disrepute, their place being occupied by ball soaps.

Castile Soap, otherwise known as *Marseilles Soap*, is made from olive oil and caustic soda. This is produced both in the white and marbled state, for which the addition of a little ferrous sulphate will be necessary. The former is said to be the purest, the latter the strongest. The object of marbling the soap with an insoluble matter is to show that it contains but little moisture, since, if too large a proportion of water were present, the colouring matter would sink to the bottom and remain there instead of being diffused throughout the mass.

Curd Soap is made from tallow, only a small portion of lard or coconut oil being added to ameliorate its hardness and give it softness. The soap owes its name to the special method of boiling and separating the soap out in the form of curd before being framed. Various scented soaps have the pure curd soap as their basis.

Dye Soap.—These soaps have got the special property that they impart suitable colours to the soap while they cleanse the cloth. Various aniline dyes may be incorporated in the soap stock for the purpose. The manufacture of these soaps may be taken up in India.

Glycerine Soap is generally a toilet soap from tallow and fats and is essentially a mixture of soap and glycerine. The soap is often finished so as to be transparent to view.

Gola or ***Bagmari Soap.***—This is grained soap of high quality prepared at Bagmari, a suburb of Calcutta. It is very popular among the *dhobis.*

Honey Soap is quite a misnomer. It contains no honey. It is usually a good yellow soap scented with the oil of citronella.

Marseilles Soap, also much in vogue among the dyers and calico-printers, is prepared much in the same manner as the Monople Soap. Simply in this instance sulphonated olive oil is employed in place of sulphonated castor oil.

Milled Soap is a settled and fitted soap which has been milled properly. This generally refers to the best quality toilet soaps having compact texture and uniform consistency.

Monople Soap, much used by the dyers and calico-printers, is prepared by the complete saponification of some sulphonated oil, preferably castor oil, with caustic soda.

Mottled Soap is prepared from refuse kitchen stuff or low grade tallow and presents a marbled or mottled appearance. The soap generally contains a small quantity of ferrous sulphate or green vitriol to which it owes its peculiar colour. By exposure to the air the iron salt gets oxidised and a reddish tint is diffused over the bluish mottled mass.

Moulded Soaps are so called because they are moulded in earthen cups more or less of the shape of a hollow hemisphere. These have a better soap value than other varieties of washing soaps and are much used by the washerman. These are also made by the boiling process but the method of salting out in this case is rather laborious.

Pale Soaps are generally laundry soaps for domestic purposes, have a pale yellow colour and generally contain a fair percentage of rosin to help the lathering property. These are made by the boiling process.

Shaving Soap.—As the very name suggests the soap is used before shaving. The soap is made in the form of sticks. It should be capable of forming copious lather which persists for a time. The soap should be free from excess of alkalis and should be perfectly non-irritant.

Tablet Soaps and *Ball Soaps* are so named because of their being finished in the shape of cakes carrying designs and balls having definite weights. The names have generally nothing to do with the process of manufacture.

Transparent Soap owes its name to the transparent nature of the finished cake. This property is developed by the special method of its manufacture and by incorporating various filling agents.

Windsor Soap has generally the curd soap as the basis, only a little scent such as oil of carraway supported by a little oil of bergamot, lavender or origanum, musk, etc. is incorporated for perfume. Brown Windsor soap is nothing but the white variety coloured with a little burnt sugar or what had turned mellow and brown with age.

CHAPTER II.

RAW MATERIALS IN SOAP MAKING.

THE raw materials for soap manufacture cover a wide range of substances which may mainly be classified under the following classes :—

(1) Fats and Oils.
(2) Alkalies.
(3) Rosin.
(4) Salt.
(5) Filling Agents such as soap stone, sodium silicate, starch, etc.
(6) Soap Colours.
(7) Soap Perfumes.
(8) Water.

As success in manufacture would depend upon the selection of the raw materials, a general description of the raw materials and their chemical properties from the soapmakers' point of view will be very instructive. These properties are to be kept in view if a particular type of soap fulfilling special conditions is to be manufactured successfully.

TALLOW.

Tallow is procured chiefly from the fat of cows, bullocks, buffaloes, sheep, goats and similar animals. It is separated by fusion from the membranes and fatty matter by *rendering*, a process involving the use of heat and steam.

Tallow as available in the market is very variable in quality and colour. The tallow obtained from the thick fatty deposits surrounding the abdomen is considered to be of the highest quality and is much used for edible purposes. Inferior qualities of tallow are obtained from hollow bones of animals and are commonly known as *bone grease*, *bone fat*, *bone tallow*, *marrow tallow*, etc. An oil separates out when melted tallow is allowed to crystallise out. This is known as *tallow oil* and is also employed in soap making to some extent. The genuineness of tallow can be tested by its specific gravity (0.943 to 0.942) and melting point (42° to 46°C).

When boiled with caustic alkalies of 10° to 12° Be. tallow is converted into soap. Use of stronger alkalies is inadvisable as in that case the first formed soap tends to separate out, thus hindering further saponification. Usually 13.79 to 13.85 per cent. of caustic soda or 19.32 to 19.38 per cent. of caustic potash is required to convert the tallow into soap. Amount of salt to be added for purpose of graining and settling the soap is the smallest in the case of tallow, this being 8 to 10 per cent. of the waste lye. Chemically speaking, tallow is composed of stearine, palmitin and olein in varying quantities.

Tallow gives a soap of uniformly compact texture without any objectionable odour. It is therefore often blended with other oils and fats to impart firmness or body to the soap. Soap from the finest tallow is white but that made from the common varieties appears brown. The soap is what is technically known as *hard soap*, lathering scantily in water but the great advantage of tallow soaps is their excellent cleansing and keeping properties. They are not wasteful in use. Though hard on ageing, they generally keep well and do not get rancid like soaps made with other oils. Another important property of tallow is that its use as a soap stock increases the amount of water that can be added to a soap without an excessive sacrifice of firmness. When soaps from oils appear soft, tallow soaps are often added to give them a firmer body.

Tallow comes from three sources in India, viz., buffalo, oxen and sheep. The tallow from buffalo and sheep is pure white in colour and exhibits grains which are a bit firm. That from oxen is yellowish with soft grains. Australian tallow of the first class is fine white. It is the best tallow in the market.

Tallow Oil also gives good white soap which is softer than tallow soap.

LARD.

Another animal fat required in the soap industry is lard, which is chiefly composed of stearine and olein. It has got varied uses in medicine and cookery and is rather a costly material. It gives a better soap than tallow but owing to its high price it is employed in soap making on a restricted scale, being used only in the manufacture of the best grades of toilet and shaving soaps.

Lard is the fat separated from the membranes and blood of the hogs. The fat which surrounds the kidneys yields the best and finest lard. It is white, soft (slightly harder than butter) and pultaceous. Some varieties are of faint yellowish or creamy tint.

Lard has a specific gravity of 0.931 at 15°C and 0.881 at 50°C. Its melting point is 40° to 42°C whilst its solidifying point is 27.1° to 29°C. It contains 96 per cent. of insoluble fatty acids. Lard requires 14.0 per cent. of caustic soda or 19.5 per cent. of caustic potash for neutralisation and the soap obtained is white, odourless, of uniform texture, and lathers freely in water. It does not go rancid on keeping.

Lard Oil, an oily substance formed during the manufacture of lard, has been found unsuitable for soap manufacture.

COCONUT OIL.

From the Indian soap makers' point of view coconut oil is the most important of the fatty substances suitable for soap making. It is available in great abundance on the Malabar and Coromandel Coasts and the lower basins of the Ganges, the Brahmaputra and the Irrawady. Cochin variety of the oil is the most prized as being free from free acids and yields soaps of the highest quality. Calicut and Alleppey varieties are also good.

Coconut oil has a pleasant odour, characteristic of its own. Its specific gravity is 0.93 at 15°C and 0.87 at 100°C. It melts at 20° to 25°C and remains in the liquid state for the greater part of the year. It is saponified readily, taking a stronger alkali (20° to 22° Tw) than any other fat at the ordinary temperature with the evolution of much heat. It lends itself to the cold process of soap making with the greatest facility. But one great drawback which the oil suffers from is that it goes rancid on keeping and gives out an offensive smell. The oil consists of stearic, palmitic, oleic, myristic and lauric acids as triglycerides and contains small quantities of lower acids, butyric, caproic, etc.

The oil requires 18.2 to 18.6 per cent. of caustic soda and 25.5 to 26 per cent. of caustic potash for complete neutralisation. With weak lyes the saponification is retarded till the lye gets concentrated to 20° to 22° Tw as against 10° Tw in the case of tallow. The oil fobs considerably and special precautions are to be taken to prevent boiling over. During graining the oil requires twice as much salt as tallow or any other oil.

Coconut oil yields a good white soap, lathering freely in both fresh and salt water. The lather, however, is of thin body and lacks permanency, which is a feature of lard soap. The oil is therefore made the chief basis in the manufacture of marine and hard water soaps. It is capable of taking up a very large percentage of water and filling agents which would go to cheapen the cost of production. It is also used in making toilet soaps but the product is rather harsh to delicate skin unless blended with other oils.

The soap from coconut oil is fairly hard in consistency but is rubbed off easily. It is often used in admixture with tallow to give the soap a greater lathering property. This admixture will also prevent cracking of the tallow soap when dried up. The yield of glycerine from coconut oil is also great being 12 per cent. of the soap. The soap, however, does not keep well long and is likely to go rancid on long keeping.

PALM OIL.

Palm oil is obtained from the fleshy portion of the fruit of the oil palm (Elacis Guincensis) and forms a good basis for soap manufacture.

The oil varies from a light yellow to a dark red colour and is sometimes of a buttery or tallow-like consistency. The fatty acids contained in the oil are chiefly palmitic and oleic.

From the soap manufacturers' point of view palm oil makes an excellent soap stock yielding a pale soap of a firm texture and compact body. It can be treated by the cold process also. For those having objections to the employment of tallow in the soap stock, palm oil will form a good substitute. The oil also constitutes a good ingredient in toilet soaps, but such soaps are liable to lose their scent readily. Like tallow it can be used with coconut oil.

The oil melts at 27° to 30°C and solidifies at 30° according to the age and origin of the oil.

The oil requires 14.0 to 14.7 per cent. of caustic soda for complete saponification. The percentage of caustic potash for the same purpose comes up to 19.7 to 20.3.

COTTON SEED OIL.

Cotton seed oil is available in abundance in India in the cotton-bearing tracts and can be used as a soap stock. The soap made from crude cotton seed oil is good but the colour is rather dirty, moreover it contains a considerable proportion of free fatty acids which may be as high as 21.6 per cent. But the refined oil is a clean bright oil of a pale yellow colour and produces a white soap but this is liable to be soon discoloured and does not also keep well. The oil, however, may be used in admixture with other fats and oils in suitable proportions.

Cotton seed oil has a specific gravity of 0.916 to 0.930 at 15.5°C. The flash point of the oil is 475°F and it solidifies at 0°C to 1°C. It requires 19.2 to 20.0 per cent. of caustic potash and 13.71 to 14.3 per cent. of caustic soda for complete neutralisation. The process of saponification in the case of cotton seed oil is rather difficult, the lye remaining in the body of the soap. The soap is therefore hard to obtain in a neutral condition. Saponification is best begun with caustic lye at 15°Be; addition of soap scraps or admixture with easily saponifiable fats accelerates the operation.

The soap also is not so easily grained as tallow soap. Cotton seed oil yields a soap of thin body which can be hardened by mixing soda ash and sodium silicate. It is darker than the tallow soap and is comparatively easily soluble in water. It is more soluble in water than tallow soaps and therefore lathers freely but the lather does not last as long as the soap made from tallow and other fats. An addition of tallow hence improves the washing property of the soap.

The soap made from cotton seed oil has a pale reddish tinge and a high detergent property but often gets rancid on long storage. The oil is much used in making pale soaps and floating soaps.

The oil appears to consist chiefly of the glycerides of palmitic, oleic, linolic, myristic and stearic acids.

LINSEED OIL.

India's resources of linseed are quite immense. Large crops grow in Bihar and Orissa, United Provinces, Central Provinces and Berar, Hyderabad, Bengal, Bombay and the Punjab.

The oil is rather limpid with a greenish yellow colour. It has got extensive applications in arts and industries. It is, par excellence, the most important drying oil of commerce and is much employed for the manufacture of paints. The oil is also prized by the soap manufacturers, for the manufacture of special kinds of soaps, mainly soft and transparent. The glycerides of linolic acid and isolinolic acid constitute 60 to 70 per cent. of the oil.

The oil occurs in various shades of colour (from yellow to light orange), has a specific gravity of 0.935 at 15°C and 0.8881 at 100°C, the flash point being 130°-140°C. The oil requires for complete neutralisation 18.9 per cent. of its weight of caustic potash or 13.35 per cent of its weight of caustic soda. The saponification takes place readily, simply on boiling. When the oil is saponified with caustic soda, the soap obtained has an unpleasant reddish colour. This is what makes the oil useless in the preparation of ordinary domestic soaps. But the oil when boiled with caustic potash yields a brownish yellow soap free from any objectionable odour. The soap is very soluble, lathers profusely and has got a characteristic odour. This has got the additional property of giving clear transparent soaps, and it is this property which leads to the general preference among the soap manufacturers for linseed oil when soft soaps are wanted. The oil is often used in combination with fish oil and cotton seed oil.

CASTOR OIL.

Another oil from the vegetable source is that from castor plant which flourishes most in Madras Presy., Hyderabad State, Bombay Presy., Central Provinces, United Provinces, Bihar and Orissa. The oil can also be used alone or in conjunction with other oils in the manufacture of soaps. The oil can be made into soaps by the cold process with great readiness with lye 32° to 34°Be. Linseed or coconut oil is often added to soap stocks containing castor oil to improve the lathering property.

Castor oil varies in colour from light yellow to dark brown, and possesses a characteristic smell and its specific gravity at 15.5°C ranges from 0.962 to 0.965. It solidifies at —18°C. The most important constituent of the oil is triglyceride of ricinoleic acid. It also contains smaller amount of oleic and linolic acids and smaller amounts of saturated oils. Acid value rises up to 7.0 per cent.

The oil gives a very soft soluble soap with caustic soda and is easily saponified. It cannot take up much water. Castor oil being freely soluble in alcohol, castor oil soap is very clear and transparent. It is therefore used in preparing the cheaper kinds of transparent soaps. It is but sparingly soluble at ordinary temperatures in light petroleum spirit in which other oils dissolve readily. It takes from 12.64 to 13.1 per cent of caustic soda and 17.7 to 18.3 per cent of caustic potash to saponify it, rather less than that required by the majority of fats and oils. A stronger lye from 15° to 18° Tw can be used and it is easily boiled up. The soap lacks in detergent property.

GROUNDNUT OIL.

Another important soap stock is the groundnut oil which is extracted on a large scale in Madras and Bombay Presidencies. The cold drawn oil is a pale limpid liquid of pleasant taste and is mainly used for edible purposes. It contains less than 1.0 per cent of free fatty acid. The second and third pressure oils are exclusively used by the soap manufacturers.

The fatty acids of the oil consist principally of oleic and linolic acids and small quantities of palmitic, stearic, arachidic and lignoceric acids. Its specific gravity varies from 0.916 to 0.919, solidifying at 2°C. It gives a soap of white soft body, the colour depending upon the grade of the oil used. The soap gives only scanty lather. Hence it is rarely used alone in the manufacture of soaps but is used along with tallow and oils that would give a firm body. It is evident therefore that it is not suitable for treatment by cold process. It requires 12.86 to 14 per cent by weight of caustic soda for neutralisation and 18.0 to 19.6 per cent by weight of caustic potash.

MAHUA OIL.

Mahua is found in plenty in Bengal, Bihar and the greater part of Central India.

Mahua oil has come into large use among the soap makers. It is cheap and gives a soft body to the soap. It is used along with other oils to give a balanced soap stock.

The oil is much used in laundry and cheap toilet soaps on account of its low price. The oil has a pale yellow colour but oil of light yellow colour is also met with. It ranks now-a-days as one of the most important soap stocks and is generally used in conjunction with coconut oil, tallow, sesamum oil, etc. It is often substituted for animal fat.

The soap from the mahua oil has a rather soft consistency. It gives thin but ample lather. When wheat flour is used in the soap as a filler it can absorb much water.

The oil requires 13.6 per cent of its weight of caustic soda and 18.7 to 19 per cent of caustic potash. The soap solidifies after graining at 57°C.

SESAMUM OIL.

Sesamum oil is available in large quantities in Upper India and the Madras Presidency. It makes a useful soapstock, is light-coloured and fairly rich in "stearines" which are deposited on allowing the oil to stand in the cold. The oil frequently contains large quantities of fatty acids consisting of a mixture of about 78 per cent of liquid acids (oleic and linolic) and 12 to 15 per cent of solid acids (palmitic, stearic, etc.).

The oil has a specific gravity of 0.923 and requires 13.49 to 13.66 per cent of its own weight of caustic soda and 19 to 19.24 per cent of its weight of caustic potash for complete neutralisation. The strength of the lye should best be 36° to 37°Be.

On account of the large quantity of fatty acid present in the oil, it does not lend itself to treatment by the cold process. The oil, however, can be made into soaps by the boiling process. Usually mahua, coconut, castor and other oils are mixed with this in the making of laundry soaps to improve the quality.

Soaps produced from sesamum oil are white in colour and lather profusely. The soap is of medium consistency.

FISH OIL.

Fish oil in hydrogenated state is now used in the manufacture of cheap soaps. The oil is amenable to treatment by the semi-boiling and boiling process. It requires 13.5 per cent of caustic soda and 18.9 per cent of caustic potash for complete neutralisation.

OTHER OILS

Among other oils which may be used in soap making are rape or mustard oil, etc., but their use is rather restricted. The runnings of mustard oil are used by some manufacturers to reduce the cost of production.

Researches conducted by the Department of Industries, Bengal, have brought to the forefront a number of oils which now go to waste for want of industrial applications. Some of these oils, specially *neem oil, punnal oil, rayna oil* and *karanja oil* have been found to be suitable for the soap industry. They give soaps having good detergent properties, and in Bengal which is rather deficient in soap making materials their use is recommended on a larger scale than hitherto. We are indebted for the following accounts of these oils to the Bulletins published by the Department of Industries, Bengal.

NEEM OIL

Margosa oil, commonly known as Neem oil, is the oil obtained from the seed of *Melia Azadirachta,* a large evergreen tree growing wild throughout the greater part of the Indian Peninsula. Certain medicinal properties are attributed to the oil which has accordingly some application, a nominal quantity only being used by a few soap-makers to make medicinal soaps possessing the odour of the original oil. The oil contains oleic, palmitic and stearic acids with smaller quantities of linolic, arachidic and lignoceric acids. The oil possesses a characteristic odour and requires some treatment before use.

Neem oil is a stock capable of producing a fairly hard soap, and, as such, should be highly valued, since most of cheap soap stocks available from vegetable source in India are of the soft kind. The soap from Neem oil is almost as hard as the mahua soap.

The oil has a specific gravity of 0.9143 at 30°C and requires 19.62 per cent of caustic potash and 14.01 per cent. of caustic soda for complete neutralisation. The oil is, therefore, quite suitable for the making of grained soap, moulded or stamped. Unsaponifiable matter is present to the extent of 2.3 per cent. in the cil while the acid value is 5.7.

Neem oil saponifies readily and the soap produces profuse lather which is slightly greasy. But the oil gives a perfect washing soap in judicious mixture with other harder and softer stocks, but special treatment is necessary in this case.

RAYNA (AMOORA ROHITUKA) OIL.

The Rayna grows wild in the Gonda forests, in the Sikkim Terai, Assam, Chittagong, Northern and Eastern Bengal, and the Western Ghats.

The fresh oil drawn from rayna has a deep red colour with a cloudiness and an odour which is neither strong nor very disagreeable. On standing, the oil becomes clear, and a solid fat separates from it and settles at the bottom, having a colour much less deep than that of the oil itself. The fresh oil has a specific gravity of 0.9016 at 29.5°C and a saponification value of 198.27, *i.e.*, the oil would require 19.827 per cent. of its own weight of caustic potash for saponification.

The oil contains a larger proportion of unsaturated fatty acids which impart a soft consistency to the soap made from it, while endowing the same with high lathering and detergent qualities. The oil can therefore replace linseed oil or other soft stocks commonly used in admixture with the hard soap-producing fats and oils for the proper softening of the body of the soap. The oil contains resinous matter, which also adds to its cleansing and lathering properties, but at the same time makes it unsuitable for soap-making by the cold process. It can be used in making moulded soaps. The oil does not show any unusual behaviour on boiling with caustic soda, the saponification proceeding normally and the resulting soap graining out rapidly on salting.

The colour of the soap does not undergo any change on storage. Of scarcely less importance is the resistance which the soap from this oil offers to rancidity. Further the slightly aromatic odour which the Rayna oil soap possesses remains intact for a long time.

KARANJA (PONGAMIA GLABRA) OIL.

Karanja or Pongam oil is obtained from the seed of Pongamia Glabra. The oil is used in small quantities in Southern India for the manufacture of settled soap.

The oil has a specific gravity of 0.929 at 31°C and a saponification value of 185.3, *i.e.*, it requires 18.53 per cent of its own weight of caustic potash for saponification.

The oil contains a compound substance having a disagreeable smell which is passed on to the soap unless removed beforehand by bringing about its decomposition. The latter is brought about by protracted boiling with caustic soda in course of saponification. The oil cannot therefore be used by itself or in combination with other oils and fats for making soap by the cold process free from objectionable odour.

Karanja oil saponifies fairly easily to form a soap of a soft consistency and having good cleansing properties. It lathers freely and has a thick greasy feel, the latter due to the presence in the oil of some resinous matter which is converted into soap. The stock has been found to be suitable for the making of moulded and settled soaps in admixture with other stocks, the soaps still possessing good lathering and cleansing properties.

Since Karanja oil is a comparatively soft stock, moulded soap of the proper degree of hardness cannot be made of a mixture of oils and fats containing more than 25 per cent. of this oil. Having regard to the other requirements of the soap it will be found convenient to use the oil in proportion lower than the maximum stated above, for ensuring good body and high cleansing property to the soap. Soaps made from mixtures containing higher proportions of Karanja oil than 25 per cent. will dissolve too quickly. Such soaps will have a tendency to turn slightly brownish on long storage. In a moulded soap, however, a brownish colour is not generally considered so much a disqualification.

The soap made entirely from Karanja oil can be grained and moulded, but it develops a dirty brown colour on prolonged storage. The soap grained over brine has a solidification point of 39°C as against 66.5°C for tallow, 57°C for mahua oil, 54°C for punnal oil, 52°C for rayna oil and 54°C for groundnut oil.

PUNNAL (CALOPHYLLUM INOPHYLLUM) OIL.

The proper use of the oil as a soap stock is, however, little understood and hence it is being used only in the preparation of the cheap classes of soaps of indifferent qualities.

The oil as expressed has a light yellow colour with greenish tint which deepens on standing. The oil has a tendency to deposit particles of solid fat. It has a characteristic odour, not very disagreeable, by which it can be identified unmistakably. On cooling, the oil begins to thicken at 5°C and becomes a viscous solid at about 0°C. The freshly expressed oil has a specific gravity of 0.932 at 36.5°C and requires 19.4 per cent of its own weight of caustic soda for saponification.

The presence of comparatively large proportions of free fatty acids and resinous matter in the oil interferes with the slow and progressive saponification of the stock, so necessary for success in the cold process and thereby renders the complete saponification of the oil an impossibility.

It has been found that the oil is saponified easily on boiling and the soap made entirely from this oil has a dark yellowish-brown colour. The soap is, however, free from odour and has a soft consistency. It has good cleansing properties and a very mild action on the skin. The lather is quick and abundant.

The brownish colour which the soap develops is calculated to be a disadvantage in the use of the oil by itself. In admixture with other stocks, however, the oil can be used up to 35 per cent. with great advantage in the making of all varieties of moulded soaps having high cleansing and lathering properties. By refining the oil, larger proportions of this stock up to 70 per cent. can be used in admixture with other stocks in the making of the above-mentioned soaps. The refining eliminates most of the resinous matters present in the oil and considered to be responsible for the disadvantageous colouring substance.

SAFFLOWER OIL.

Safflower oil, obtained from the seeds of Carthamus Tinctorius is grown in different parts of India. The oil has a specific gravity of 0.9253 to 0.9280 at 15.5°C. It requires for complete saponification 18.7 to 19.2 per cent. of caustic potash and 13.36 to 13.79 per cent. of caustic soda. Iodine value of the oil is 129.8 to 149.0. The oil is better used in the manufacture of soft soap than in the manufacture of hard soap.

CHAULMOOGRA OIL.

The oil is extracted from the seeds of Taraktogenpus Kurzii, a tree found in Assam, Bengal and Burma.

The oil is known for its high optical rotation. The average specific rotation at 15°C is about 50. The importance of the oil lies in its use as medicine. It has been used for many years in the treatment of leprosy and other skin diseases. The oil has a specific gravity at 30°C of 0.945 to 0.952. The oil requires for complete saponification 19.8 to 20.8 per cent. of caustic potash and 14.14 to 14.86 per cent of caustic soda. The composition of the oil has not been fully worked out but its fatty acids include chaulmoogric and hydnocarpic acids as well as palmitic acid.

CAUSTIC SODA.

One of the most important ingredients in soap making is the caustic soda. Formerly the caustic soda was made by the manufacturers themselves by treating soda ash with lime water. But this method of lye making is now obsolete as caustic soda of reliable quality may be had ready at hand at cheap prices.

Caustic soda comes into commerce in four forms:

(1) sticks,
(2) flakes like scale of fishes,
(3) blocks in casks,
(4) solution.

The caustic sticks are, however, rarely used in soap making on account of their high prices. Caustic liquors are not also taken into credit for containing too much impurities. Flasks are too costly for large use. In fact blocks are mostly in use.

Commercial caustic soda is a creamy or white mass, having a slightly fibrous structure. It is very hygroscopic, readily absorbing water from the air and passes into a highly caustic liquor. It also readily absorbs carbonic acid from the air, passing into carbonate so that it is not desirable that caustic soda should be exposed too much to the air.

Caustic soda is sold in the market in a variety of grades, each grade containing a definite percentage of caustic soda.

Grade	per cent of caustic soda.
60°	77.42
70°	90.32
72°	92.90
74°	95.48
76°	98.06
77°	99.35
77.5°	100.00

The figures indicating the grade have a significance. The degrees represent the percentage of sodium oxide present in the alkali. The highest grade, containing as it does more available caustic soda and less impurities is much more advantageous to use. For example, 77.5° caustic soda means that 77.5 parts by weight of sodium oxide are present in 100 parts of the caustic soda. And since from the molecular weight of the caustic soda it appears that 80 parts of the soda contain 62 parts of sodium oxide, 77.5 parts of sodium oxide must be present in 100 parts of the caustic. It therefore comes to this that cent per cent pure caustic soda is designated as 77.5°, while a caustic soda of 90.32 per cent. purity will contain 70 parts by weight of sodium oxide and will consequently be designated commercially as 70°.

The amount of caustic soda required to neutralise various oils and fats is given in the following table:—

Almond Oil	13·4 seers	to 14·0 seers
Castor Oil	12·6 ,,	to 13·1
Coconut Oil	18·2 ,,	to 18·6
Cotton Seed Oil	13·7 ,,	to 14·3
Fish Oil	12·8 ,,	to 13·5
Groundnut Oil	12·9 ,,	to 14·0
Lard	13·9 ,,	to 14·0

Linseed Oil	13·4	seers	to 13·9	seers
Mahua Oil	11·2	,,	to 13·6	,,
Mustard Oil	12·4	,,	to 12·6	,,
Olive Oil	13·2	,,	to 14·0	,,
Palm Oil	14·0	,,	to 14·7	,,
Rapeseed Oil	12·0	,,	to 12·8	,,
Rosin	12·2	,,	to 13·8	,,
Sesame Oil	13·5	,,	to 13·7	,,
Sun Flower Oil	13·3	,,	to 13·7	,,
Tallow	13·8	,,	to 13·9	,,

CAUSTIC POTASH.

Caustic potash possesses chemical properties very similar to those of caustic soda. Only it is much stronger in chemical action than the latter in every respect. But from the manufacturers' point of view there is an essential difference between the soaps produced with caustic soda and caustic potash. As already mentioned (*page* 3) the soaps made with caustic potash are generally softer in consistency and more soluble in water than those made with caustic soda. Hence when soft soaps are to be manufactured caustic potash is requisitioned but it is rarely used in making ordinary domestic soaps. In making toilet soaps sometimes a fraction of the total alkali consists of caustic potash.

Caustic potash dissolves readily in water forming a lye with considerable evolution of heat. It is hygroscopic and readily absorbs carbon dioxide from the air and is converted into potassium carbonate. Hence it is of the utmost moment to the manufacturers that the caustic lye should be as little exposed to the air as possible.

Caustic potash, it requires no mention, neutralises fatty acids to soaps. But generally the percentage of the potash is rather higher than in the case of caustic soda. Usually 18.5 to 20 p.c. of pure caustic potash is required for saponification as against 13 to 14 per cent. of pure caustic soda. As a matter of fact the quantity of caustic potash required to neutralise a sample of oil is exactly 1.4 times the quantity of caustic soda required for the same purpose.

The soaps made with caustic potash are soft and dissolve readily in water. The soaps therefore lather more freely.

SODIUM CARBONATE.

Next in importance among the alkalies is the carbonate of soda. Formerly, it was consumed in huge quantities by the soap boilers to prepare their lye at the factory but now-a-days the caustic soda having come into wider use, the sodium carbonate is employed rather on a restricted scale. It cannot be safely used in making soaps from high grade oils and fats and can only be made use of in the preparation of soaps from free fatty acids. The carbonate is used by the fullers as such in cleaning dirty cloths and has good detergent properties though it is not quite non-injurious to the softer materials.

The carbonate of soda occurs in the market in five distinct forms, *viz.* soda ash, refined alkali, soda crystals (occurring in large crystals), crystal soda (occurring in small crystals) and bicarbonate of soda. Of these, soda ash is used to a limited extent by the soap boilers. Two forms of it are available, *viz.* caustic soda ash and carbonate ash and possess varying degrees of strength known as 48 degrees, 50 degrees, 52 degrees, up to 58 degrees. The degrees refer to the amount of alkali present in terms of sodium oxide but expressed as English degrees.

Soda ash 48°, sometimes called caustic soda ash, often contains besides carbonate of soda, 4 per cent. caustic soda (sodium hydrate) and 10 per cent. salt (sodium chloride) together with water and impurities.

Carbonate of soda or soda ash 58°, also termed "light ash" and refined alkali, is commercially pure sodium carbonate containing about 0.5 per cent. salt. The 58° represents the English degrees and corresponds to 99 per cent. sodium carbonate. It is better to use the 58° stuff than the 48° one.

Soda crystals or Washing soda is often added to the soap to the extent of 5 per cent of the soap ; a larger quantity cannot be used as it would cause much effervescence on the soap. This material both cheapens the cost of production and adds to the detergent properties of the soap.

Soda Crystal is also an important filling agent in so far as it has got detergent properties and prevents loss of soap by softening the hard water during washing. This also has a hardening action on the soap. It is often added when water is found in excess in the soap, or in pale soaps where use is made of resin. But a large use is to be avoided as it would cause formation of saline efflorescence on the soap.

It is not judicious to use more than 5 to 10 parts of soda to 100 parts of the oil.

CARBONATE OF POTASH.

The standard for refined carbonate of potash is 90-92 per cent of actual potassium carbonate present, although it can be obtained testing 95-98 per cent. It has got the same properties as sodium carbonate but is less used than the latter.

SALT.

Salt is required in large quantities in manufacture of soaps. It is mainly used for graining the soap out from a mixture of oils and alkalies. Soaps being insoluble in strong brine separate out when salt is added in quantities to make the mixture saline. The quantity of salt required for the salting out process in the case of the various oils and fats is a very variable quantity. Salt is added solid but sometimes it is made into brine of special strengths before addition to the waste lye. The usual quantity of salt to be added to 100 parts of the oil is 12½ parts.

ROSIN.

Rosin finds wide applications in the manufacture of pale laundry soaps. It is brittle and transparent, its colour varying in shade greatly according to the quality of the product. For pale soaps only bleached and white rosin commonly known in the trade as W.W. *i.e.* water white and W.G. *i.e.*, window glass can be used; for dark coloured soaps the common varieties can be employed with impunity.

Addition of rosin increases the cleansing power of the soap, promotes the formation of lather, ameliorates the firm type of soaps, avoids rancidity and imparts a sweet balsamic aroma. Hence soaps made of fat, which are sparingly soluble in water and give only small quantity of lather are admixed with rosin. It is also added to form soaps when they are to be softened down. But one defect it suffers from is that it often causes stickiness and sweating. It is to be added in definite quantities or the soap will be of buttery consistency and lose its firmness. The amount of rosin that can be assimilated by various fats and oils depends on their very nature. Good tallow will carry more rosin than soft grease. In general, the firmer the soap, the more rosin it is capable of carrying. Usually good tallow will absorb about 40 to 50 per cent of rosin, and 25 per cent of grease without making the soap excessively soft. Rosin can be incorporated in both hard and soft soaps but the soap is rather liable to get darker with age.

It may be noted that soaps containing rosin are often yellow in colour, like ordinary household soap.

Rosin requires 12.2 to 13.8 per cent. of caustic soda for saponification.

FILLING AGENTS.

The filling agents are intended to increase the bulk of the soap without increasing its cost of production. A number of filling agents are employed by the soap manufacturers. Particular care should be taken for their selection and the proportion in which they are to be added. The addition must not be so heavy as to detract the detergent property of the soap, or affect its keeping quality. All these factors are to be reckoned before mixing them.

The more important of the filling agents are silicate of soda, starch, sulphate of soda; sugar or a combination of them. Formerly soap stone, silicious matters, kieselguhr were much used but their use is now very restricted as they have no cleansing properties and on the other hand break the grain of the soap and make it wasteful.

The most important of the lot is however the silicate of soda and potash, specially the former.

SODIUM SILICATE.

Sodium silicate is brittle, breaking with a conchoidal fracture and resembles glass. Liquid sodium silicate is a viscous liquid (50° Be, Sp gr. 1.50—1.54). Generally it is of an alkaline character and possesses good detergent properties. Neutral silicates containing smaller proportion of soda are often used.

Usually 5 per cent is the quantity employed in making pale soaps and such a quantity will harden a soap. The proportion of the silicate is sometimes increased to 25 per cent. If, however, the proportion largely exceeds this, then the tendency is for the soap to become pasty and very wasteful in use.

The presence of silicate of soda increases the alkalinity of the soap.

The detergent properties of the soap do not suffer by such addition though the soap is liable to get a bit caustic and wasteful in water. Excess of this filling agent, however, renders the soap thin.

Silicate of potash is also used by soap manufacturers, specially for mixing with soft soaps.

STARCH.

Another filling agent is starch. This has got the property of combining with water in the presence of alkalies into a gelatinous mass soluble in water. Hence this is added to make the soap of proper texture when it has got thin without dispensing with surplus water. The use of starch does not produce any alteration in the appearance of the soap but the detergent property of course deteriorates. 2 per cent is, however, a fair quantity to use but this can be used upto 30 p.c. in cold process soap. Sodium silicate of 26° Be is added to cold process soap, when the soap has thickened considerably.

GLAUBER'S SALT.

This is another filling agent which has got the property of rendering soap hard. But its use is accompanied by a very undesirable deposition of saline efflorescence on the soap which also becomes more wasteful in use and weaker in detergent properties.

SOAP STONE.

Soap stone, otherwise known as French chalk or talc, is often incorporated to the extent of 15 to 20 per cent as a filling agent. It lacks the detergent properties of silicate or soda crystal and the binding power of starch. It simply supplies a mechanical filling agent for the soap.

PEARL ASH.

Pearl ash imparts to the soap a finer texture due to the double decomposition between the soap and pearl ash. The soap is rendered smooth, transparent and hard. But excess of it renders the soap soft and pasty.

BORAX.

Borax has often been suggested as a filling agent especially because it has got a good detergent property. But it is rather expensive to be so employed and hardly goes to reduce the cost of production.

Borax is chemically known as borate of sodium and occurs in fine, rather efflorescent crystals. Borax is soluble in half its weight of boiling water and about 12 parts of cold water.

SOAP PERFUMES.

Soaps made from animal fats and oils are often attended with an unpleasant, if not offensive, smell. This has to be masked if the products are to find a ready market. With this object in view the manufacturers employ a wide range of cheap scents, natural or synthetic, to disguise the odour of the soap. Again toilet and medicated soaps have to be delicately scented. For this purpose essential oils of the best qualities are mixed. To make the fragrance lasting the use of some fixative agents such as tincture of musk, ambergris, tolu balsam, benzoin, civet, oils of Peru balsam, sandal wood, patchouli, cloves, aniseed, benzyl or ethyl benzoate, etc., etc., is recommended.

In selecting perfumes for soap care should be taken that the perfumes neither have any deleterious effect on the colour of the soap nor disturb its composition. Again suitable blending of perfumes is very much necessary as two unsuitable perfumes may by mutual reaction cancel each other.

Clove oil, cassia oil, heliotropin, vanillin when added to the soaps cause them to be discoloured or to darken in keeping. Delicate perfumes such as bergamot oils, etc., should not be added to soaps with free alkalies.

NATURAL PERFUMES.

A knowledge of the principal natural perfumes used in soap manufacture is necessary for soap makers. A list follows :—

Anise Oil.—Colourless, or at most faintly yellow oil when fresh. Has a pleasant odour and an aromatic sweet taste.

Bergamot Oil.—Has a pale yellow colour but is often met with having a greenish tint. Has a strong agreeable odour. Is largely used in scenting toilet soap. Should be kept out of contact with air. Is often replaced by lemon oil for cheapness.

Carraway Oil.—Has a light yellow colour, an aromatic odour and burning taste. Is largely employed in the scenting of soaps both alone and in combination with other essential oils.

Cassia Oil.—Has a yellow colour but turns dark brown on standing. Has a pleasant odour not unlike that of cinnamon but not so pleasant. Gives the characteristic odour to Brown Windsor soap and is useful for sweetening coal-tar medicated soaps. Causes darkening.

Cinnamon Oil.—Viscid, golden yellow or golden brown according to age and has a burning but sweet taste. Much used in soaps.

Citronella Oil.—It has a pale yellow colour and a peculiar pleasant odour. Much used by soap makers.

Clove Oil.—Colourless but soon becomes yellowish to brown and has a pleasant spicy odour and strong burning taste. Is largely used in soap making and indispensable in carnations.

Coriander Oil.—Pale yellow colour, pleasant odour, sharp aromatic taste. Very largely used in scenting soaps.

Eucalyptus Oil.—Is colourless, possesses characteristic odour, and is chiefly used in medicated soaps.

Geranium Oil.—Used largely in making rose and bouquet soaps. Particularly suitable for use in high class soaps. Has an odour like rose.

Lavender Oil.—Light yellow colour and a sharp burning taste. Only used in high class soap. The oil undergoes decomposition in the presence of air. It is scarcely used alone, oakmoss, rosemary, thyme and borneol being usually blended with it to modify and round off the scent.

Lemon Grass Oil.—A colourless oil, possessing the scent of roses or rose geranium. It is much used in scenting soaps and forms the basis of all verbenas.

Mirbane Oil.—Has a strong lasting odour. Its use is not recommended.

Neroli Oil.—Has an odour like orange, and bitter taste. It is a cheap scent and is much used.

Orange Oil.—Has a golden yellow colour and yields the characteristic odour of orange.

Rosemary Oil.—Is good and stable, imparts freshness, useful in many compounds, specially lavender.

Sandal Wood Oil.—This has got the characteristic smell of sandal wood and is yellowish in colour. It is much used in toilet soaps.

Vertivert Oil.—Gives persistent odours, good for violets.

Thyme Oil.—Excellent for imparting freshness to all kinds of soap compounds, and has got good antiseptic value.

Besides these, other oils are used by the soap manufacturers, *e.g.*, palmarosa oil, oil of sassafras, winter green oil, oil of peppermint, oil of nutmeg, oil of citron, spike oil, ylang oil, patchouli oil.

SYNTHETIC PERFUMES.

Synthetic perfumes are, however, being employed to a great extent by the soap manufacturers. The more important of them are benzyl butyrate, citral, citronellol, coumarine, eugenol, geraniol, heliotropin, ionone, linalol, rhodinol, safrol, santalol, skatol, terpeneol, etc. These are not generally used alone but are blended 2 or more together, to reproduce the odour of some well-known flowers. Modifiers are also included to impart a sweet floral touch to the body perfume. For example, oil of lavender is modified by coumarine and benzylacetate; jasmine by indol and linalylacetate; lily by bois de rose femelle and linalol ; narcissus by paracresol methyl ether and jasmilone ; rose by geraniol and phenylethyl alcohol; and so on.

The following basic bodies, amongst others, will bring about a distinct natural tone if suitably blended :—

Lilac.—Terpeneol, Heliotropin, etc.
Violet.—Ionone, Irison, Viodoron, Irisoil.
Sandalwood.—Santalresinoid, Geraniol, Phenylethyl alcohol.

Jasmine.—Benzyl acetate, Indol, Lenalylacetate, etc.

Orange.—Yara Yara (Beta-naphthol-ethyl ether), Bromelia (Beta-naphthol-ethyl ether), etc.

Rose.—Geraniol, Rhodinol, Geranilacetate, Hydroxicetronellol, Linalol, Citronellol, Phenylethyl alcohol, Reuniol, etc.

Musk.—Musk xylol, Musk ambrette, Benzylbenzoate, etc.

Clove.—Eugenol, isoeugenol.
Geldlack.—Iris Recinoid, Neroline, etc.
May Flower.—Linalol, Terpeneol, etc.
Almond.—Benzaldehydes, etc.

Geranium.—Diphenylmethane, Diphenylether, etc.
Trefle.—Amylsalicylate, Heliotropin, etc.
Hay.—Coumarine, Liquid Storax, etc.

FIXATIVES.

There are various gums and resins which have got the property of fixing the scent of the perfumes added. Chief of them are Peru Balsam, Tolu Balsam, Gum Benzoin, Myrrh, Storax, etc., etc. When these are added in the soap they make the scent lasting and do not allow them to pass off too quickly. Various tinctures and infusions are also employed for the same purpose. The most popular of them are infusion ambrette, infusion musk, tincture civet, tincture iris, etc., etc.

SOAP COLOURS.

In selecting colours for the soap care should be taken that they are not acted upon by alkalies which may be present in the free state in the soap. This precludes the use of Prussian Blue, Chrome Yellow, Alkali Blue, Magenta, etc. A large number of mineral colours was formerly employed in dyeing soaps such as ultramarine, vermilion, chrome green, cadmium yellow, caramel, ochres, etc., but as these are liable to separate out from the soap as it cools down and to form speckles unless specially attended to, their use has been now-a-days superseded by coal-tar dyes which are highly soluble in soap, can be readily mixed and produce every imaginable shade, dark and light, in the soap. The colour also should not have any deleterious action on the perfumes and should resemble so far as possible the colour of the flower whose odour is sought to be reproduced. Dyestuffs are generally preferred to pigments.

A list of the more important colours follows:—

White.—Zinc oxide, Titanium Dioxide.

Yellow.—Fluoresceine Yellow, Soap Yellow, Quinoline Yellow (water-soluble or spirit soluble), Metanil Yellow, Cadmium Yellow, Ochres, Napthol Yellow, Tartrazine, Uramine Opal.

Red.—Cardinal Red B, Ponceau 2 R, Rhodamine, Saffranine, Crocein Scarlet.

Rose.—Ponceau, Scarlet, Vermilion.

Bright Rose.—Brilliant Roses, Rhodamine B.

Deep Pink.—Erythrosine B, Eosine.

Bluish Pink.—Bluish Pink N., Saffranine, Rhodamine B Extra-G.

Green.—Fast Light Green, Ultramarine Green, Chrome Green, Alizarine or napthol compounds.

Orange.—Brilliant Orange G.

Brown.—Soap Browns, Soudan Brown, Caramel, Umbers, Burnt Sienna, Bismark brown.

Blue.—Methylene Blue, Ultramarine, Cyanole Blue FF.

Violet.—Formyl Violet S 4 B, Methyl Violet.

A variety of other shades may be obtained by mixing these different colours, e.g., a mixture of red and blue will produce violet and lilac tints; blue and yellow will give greens of various tones; red and yellow will yield scarlet rose, etc.

The colours require careful testing before use. They must be perfectly soluble in hot water, should not cause spottiness in the soap, be stable when exposed to light, and the froth caused by the coloured soap should be white.

CHAPTER III.

PRINCIPLES OF SOAP MANUFACTURE.

AS has already been stated the fats and oils essentially consist of glycerides of one or more fatty acids. When these are acted upon by water, they are split up into the constituent acids and glycerol. This phenomenon is known as *hydrolysis*. The velocity at which the reaction proceeds is greatly determined by the temperature of the mixture or emulsion of oil and water. The higher the temperature, the quicker does the hydrolysis go on. But there is a point beyond which the hydrolysis cannot take place. A reversible reaction sets in as a result of which the fatty acids and glycerol combine together to give the original glyceride and water. The process of hydrolysis is therefore never complete.

SAPONIFICATION.

The hydrolysis would continue if fatty acid is removed from the mixture as soon as it is formed. This can be accomplished by the replacement of water by sodium or potassium hydroxide or what are commonly known as caustic soda and caustic potash. The fatty acid is converted into constituent sodium and potassium salts which separate out as soap. This phenomenon is known as saponification.

When oils and fats are acted upon by alkalies, the reaction may be considered to consist of two separate and independent reactions which progress side by side. The water in the lye first hydrolyses the fat or oil into some fatty acid and glycerol while the acid in its turn is attacked by the alkali with the separation of soap.

WHAT IS SOAP.

We have thus a definition of soap and the clue to its manufacture. The word *soap* is applied to what is really a mixture of alkali salts of the higher fatty acids and water. Various inorganic salts and mineral matters may also be incorporated in the body of the soap.

The crucial point in the manufacture of soap is to select an oil or fat that can be saponified and treat it with an alkali. Mineral oils cannot be saponified and hence these can by no means be used in soap making. Even the vegetable oils and fats adulterated with mineral oils are ill suited for the purpose.

The next important feature in soap making is to arrive at a complete saponification of the oil. There should be no free acid and fat present in the soap, for that promotes rancidity of the soap. On the other hand the alkali must not be present in the free state in an excessive quantity. A slight alkalinity of the soap is allowable but not the slightest presence of free fat.

HOW SAPONIFICATION PORCEEDS.

For the best results in soap making, i.e., for securing complete saponification, the treatment of the oil with the caustic alkali requires particular care. Each oil requires a definite percentage of its own weight of the caustic alkali for complete neutralisation as has already been explained on page 24, and the reaction must also be allowed to take place at definite temperature. The concentration of the caustic alkali soaps has also much to do with soap boiling. Some oils are only saponified with strong alkalies while others are acted upon by weak alkalies. For instance, on boiling with caustic alkalies of 10° to 12° Be tallow is converted into soap; in the case of cotton seed oil saponification is best begun with caustic lye at 15° Be; in the case of castor oil saponification occurs with lye of 10° to 12° Be; coconut oil requires lyes of 15° to 18° Be. The lye is often added in batches, the strength being increased gradually as saponification proceeds. In cold process soap the strength of lye is often stronger. The strength of the alkali controls the commencement of the saponification operation. It has been found that the addition of soap scraps to the oils which are saponifiable with difficulty accelerates the reaction. The passing of superheated steam within the soap stock in the kettle is often successful in starting the saponification.

The employment of a stronger alkali than is appropriate for the particular soap stock in use is to be guarded against. The strong alkali acts too quickly upon the oil which is then thrown out as grains of soap from the oil emulsion and retards further saponification. For similar reasons weak alkalies will fail to act on the oil till it has got the appropriate strength by evaporation.

This explains the phenomenon often met with during the boiling of soap. If to a boiling soap a strong alkali be added, the soap at once exhibits grains and "opens," *i.e.*, the soapy mass becomes curdy and the waste lye at the bottom of the boiler is perceptible. But when water is added to the grained soap, it is hydrolysed once again and the whole assumes a "close" appearance and loses its grainy structure. This is known as *closing* the soap.

MODES OF MANUFACTURE.

The manufacture of soap is possible either in the cold without heating or by boiling. The various processes of soap making lend themselves to the following classifications :—

(1) Cold Process.
(2) Semi-boiling Process.

(3) Boiling Process.

In the cold process the oil, alkali and water combine together to give soap without the separation of anything. In the semi-boiling process the soap is obtained by boiling but the waste lye is not separated while in the boiling process the lye is separated.

COLD PROCESS SOAPS.

The manufacture of soaps by the cold process dates back to very old times and is the simplest of the lot. It essentially consists in adding to melted fats just sufficient alkali that will ensure saponification and produce a neutral soap. The fats and oils which are to be used as soap stock are just heated so that the fats are melted and the oils give out a cracking sound when a few drops of water are poured over them. These are then brought in contact with caustic lye and allowed to stand for a few days. The saponification goes on and the heat generated during the process accelerates the subsequent action.

The crux of the problem is the proportion of soda to be added to complete the process of saponification. If the oils and fats were primary substances consisting simply of olein or stearin or palmitin or laurin, the matter would have been much simplified. In that case chemical equations would give us the exact proportions between the glyceride and caustic soda on the one hand and the soap and glycerine produced on the other. But as a matter of fact the oils used are a most heterogeneous mixture of a large number of glycerides, and the proportions between them even in the same oil vary consideraly according to the source, quality and age of the substance.

Hence the best way to arrive at a correct percentage between the fat and the oil is to make an independent chemical analysis before treatment of each batch of oil. The usual procedure adopted is as follows :—

DETERMINATION OF CAUSTIC SODA REQUIRED.

A wide-mouthed flask of about 4 to 6 oz. capacity, provided with a glass tube passing through the cork measuring 3 ft. long and ½ in. wide is taken. 2 grams of oil or fat to be tested is taken into it. Now an alcoholic solution of caustic potash is made by dissolving 30 grams of pure caustic potash in 1,000 c.c. of alcohol. To the flask add 25 c.c. of this alcoholic solution and heat on water bath for half an hour shaking at intervals. The soap is saponified by this time. As a general rule there should be an excess of alkali in the flask and the amount of alkali present after saponification is to be found out. To do this, one should have a fair knowledge of acidimetry and alkalimetry. The test solution in the flask is diluted with water and is coloured red by the addition of a little phenolphthalein. Now take a semi-normal solution of sulphuric acid in a graduated burette and triturate. Note the number (X) of c.c.'s of acid added for discharging the pink colour. Now in another basin take 25 c.c. of alcoholic solution, boil on water bath, dilute with water, colour with phenolphthalein and triturate as before with semi-normal sulphuric acid and note the number (Y) of c.c.'s of acid used. It appears therefore (Y-X) c.c. of semi-normal solution of sulphuric acid is just sufficient to neutralise the caustic potash that went to saponify the 2 grams of oil taken. It therefore follows that (Y-X) c. c. of seminormal solution of caustic potash saponified the 2 grams of oil. Now 1 c.c. of semi-normal caustic potash contains 0.028 grs. of caustic potash. Hence, the total weight of pure caustic potash to saponify 2 grams of oil is equal to (Y-X) × .028 grs. whence by *multiplying by 50 the percentage of potash to be used can be found out.*

In the case of caustic soda the multiplying factor is 0.02 in place of 0.028.

Thus by chemical tests we have ready at hand the percentage of caustic soda to be used for saponifying various oils. In a particular case let us use a batch of 1 maund of tallow, 2 maunds of coconut oil and 3 maunds of mahua oil. Let the respective percentages as found by tests be x, y, z. This means that for 100 maunds of tallow we require for saponification x maunds of pure caustic soda, *i.e.*, for 1 maund we require $x/100$ maunds of caustic soda. Similarly for 2 mds. of coconut oil and 3 mds. of mahua oil we require respectively $2y/100$ and $3z/100$ mds. of caustic soda. Hence the total amount of soda to be added for complete neutralisation is—

$$\frac{x}{100} + \frac{2y}{100} + \frac{3z}{100} \text{ mds.}$$

Again if the soda in use be not cent per cent pure but commercial, say, of 90 per cent. strength we would require more of the soda for saponification. A strength of 90 per cent. means that 90 maunds of pure caustic soda are present in 100 maunds of commercial soda; whence we find that $\frac{x + 2y + 3z}{100}$ mds. of pure soda will be found in $\frac{x + 2y + 3z}{100} \times \frac{100}{90}$ mds. of commercial soda. This is the exact quantity of soda to be added so that the neutralisation point may be reached. Usually a little more is added to effect saponification.

PROCEDURE.

The coconut oil is best adapted for treatment by cold process but other fats like tallow can also be so *treated. In all cases, however, it is the practice to incorporate a certain percentage of coconut oil in the* batch, the saponification of which is thereby accelerated. Castor and mahua oils also may be made into soap by this process.

In making the soap put the fat or oil in a pan provided with an agitator. The fat or oil is then just heated to 70°—80°F. When melted run in the lye at the ordinary temperature into the pan and stir constantly. The mass will thicken. Now run into low and broad frames holding 2½to 3½ mds.

Particular care should be taken that fats and oils are of pure quality and free from fatty acid. If fatty acids be present, the oil is to be treated to rectify it. If this is not done, the soap will be curdy and not uniform. The fat or oil should be at the correct temperature. If it is too cold, it will set on the addition of the lye. If too hot, the saponification proceeds too quickly resulting in curdy or grainy soaps. Strength of the alkali is a decisive factor. The alkali should be of the highest grade so that the impurities do not get into the soap during saponification and spoil the appearance by causing efflorescence.

SEMI-BOILING PROCESS.

According to the semi-boiling process of soap manufacture fatty acids are made to combine direct with alkalies which are taken in proportions so that complete saturation of the fatty acids may be ensured.

First of all it is necessary to find out the percentage of alkali required to saturate an oil. This has already been given in the case of the various fats and oils. For example, coconut oil requires 17.48 to 19.05 per cent. of its own weight of caustic soda for complete neutralisation. The above fact will give us a fair idea about the quantity of alkali to be taken to saponify a given amount of oil. The alkali is made into lyes of appropriate strength. The fats or oils are brought to a boil and the alkali is stirred in slowly little by little. Boiling is continued with alkalies of greater and greater strength until all the alkali has been absorbed. Water is added from time to time to keep the mass thin and homogeneous. Finally frame and allow to cool.

During saponification the oil swells up considerably in size and special precautionary measures may be taken to prevent boiling over. The use of an agitator is recommended for the purpose; the addition of the oils in small portions at a time is also materially helpful.

BOILING PROCESS.

The oils and fats are placed in a large pan and is melted by heating. Caustic soda lye is then gradually added into the mass kept in a state of ebullition by boiling. The strength of the caustic solution and the quantity added from time to time is determined by the nature of the oil. At the outset weak lyes must be added slowly until saponification is well under way. This is indicated by the formation of an emulsion. When the saponification has once begun, continue boiling and go on adding caustic soda lye of greater strength in small quantities as long as it is being absorbed, so that much evaporation is not needed at the end to arrive at proper consistency. But the liquor should not be allowed to become too strong, for then the soap paste is cut into curds upon which the alkali cannot satisfactorily act. Water therefore is added from time to time. The emulsion should thicken gradually as the saponification proceeds. The concentration of the lye in the kettle is ascertained by taking out a small sample with a trowel from the pan from time to time and applying a little of the cooled sample on the tongue. The strength of the alkali can be felt from *the intensity of the caustic taste. Add caustic soda so long the strength of the caustic soda falls down.* When no more alkali is used up or the strength remains unchanged, the saponification may be considered for ordinary purposes to be complete, *i.e.*, the fats and oils taken in the pan have been neutralised by the caustic soda lye already added.

TESTING FOR SAPONIFICATION.

Besides the tongue test, there are other tests to see if the saponification is complete or not. Expert soap makers can detect this from the changes of colour, grain, firmness and general appearance. They take out a sample of soap with a trowel and examine it. When there is no greasiness in the sample and it feels firm and dry when pressed between the fingers and thumb, the soap is considered to be properly saponified and ready for being framed.

The following tests taken from Bulletin No. 31 of the Department of Industries, Bengal, will be found materially helpful to the newcomers in the line.

Usually the solution, after the completion of the saponification, becomes clear and assumes a brownish colour. The completion of the saponification is also ascertained by the following test, which is called the "ring test." A quantity of the soap is taken in a trowel and a drop from it is caught on a glass pane, or a slate, or the clean floor. This drop should be watched as it cools. If, in cooling, the edge of the drop solidifies first to form a white ring, and the central portion remains transparent until it gradually solidifies, the solidification proceeding from the edge towards the centre, then the saponification is complete. If secondly, the drop in solidifying forms something like a ring in the edge, but the central portion is turbid before solidification, and the solidification is irregular, then it indicates the presence of unsaponified fat or oil. If thirdly, the drop solidifies without the formation of the ring, and a watery substance separates from the solidified soap, the fact shows that the alkali is present in excess.

The completion of the saponification can also be ascertained by the "ribbon test," as it is called. A quantity of the soap is taken on a trowel and allowed to trickle down from it. If in so doing the soap forms transparent ribbons, it indicates that the saponification is almost complete. A turbid ribbon discloses the presence of unsaponified fat or oil. If again, the soap, in falling from the trowel shows a solidified but broken film, which glides down readily, the fact indicates that the alkali is in excess. The ring test, or the ribbon test, is often good enough, but it cannot distinguish between a very slight excess or deficiency of the alkali which can only be detected by the tongue test. The end of the saponification should be made when a slight excess of alkali persists even after continuing the boiling.

GRAINING OUT OR SALTING OUT.

The pan now contains saponified fat or soap, excess of alkali and glycerol mixed together. If the soap is to be of good quality, either the excess of alkali must be removed from the soap or the soap is to be separated out from the mass and the lye left after the operation may be treated for recovery of glycerol, if possible.

The separating out of the soap still in solution from the mixture is accomplished by the addition of salt. This happens because soap is insoluble in a strong saline solution.

When the saponification point has been reached and the soap is still on the boil and has assumed a thick consistency a saturated solution of common salt

40°Tw, is added little by little, to throw out the soap. If salting is started when the soap is diluted, a large amount of salt will be required. Instead of using brine solution, salt may be spread uniformly on the surface. *The boiling is continued slowly. The soap loses its smooth transparent appearance and becomes granular and opaque.* This is technically known as "opening" the soap.

The amount of salt required for the operation changes with the nature of the raw materials used. When tallow is employed as a soap stock, the soap is grained easily; more salt is, however, required in the case of cotton seed oil soaps while the amount to be mixed is the greatest in the case of coconut oil soap.

Excess of salt should not be added to the mass for graining, for then the soap will become granular and enclose salt. Only a sufficient quantity of the salt for the completion of the operation is necessary. Hence the most practical way of doing this is to go on adding the salt little by little and test the grained soap from time to time. The soap becomes turbid and frothy on the addition of salt. The operation is deemed complete when the frothy soap tends to separate in clots and the soap separates at the top without enclosing much froth and air bubbles, or a sample taken out on a wooden trowel presents distinct grains of soap and a liquid portion. The boiling is then stopped and the contents of the kettle are allowed to stand.

CLEANING THE SOAP.

The contents of the kettle being allowed to settle, these separate out in three distinct layers. The first consists of a thin crust floating at the top of the pan. The second layer is the actual soap which floats on the saline liquor or waste lye, which forms the lowest stratum in the pan. For ordinary purposes the soap may be ladled out carefully from above the waste lye without disturbing it or the waste lye may be withdrawn from the pan by means of a syphon or a pump provided with suitable skimmers. The waste lye may be run into tanks for the recovery of glycerine contained in it.

The grained soap is then boiled with sufficient water. The granules begin to swell up and fuse together or "close" as it is called. The soap has now a smooth appearance. If necessary, the grains of the soap may be broken during the boiling with a crutcher. This when cooled and framed gives the ordinary soap of commerce.

BOILING ON STRENGTH.

The soap is now ready but it may still contain traces of unsaponified fat. In the case of better quality soaps and toilet soaps this cannot be allowed to remain in that condition, for it would then go rancid and spoil the perfumes added. With this object in view the *boiling on strength* is carried on.

The "closed" soap, as obtained after cleaning, is treated with more alkali which is run in gradually until the soap is again grained and the boiling is continued. As the lye is being absorbed, add another portion slowly till the contents refuse to absorb more and is thrown out of solution and grained. Now continue boiling so that last traces of neutral oil may be completely saturated with the oil.

The soap solution is then just "opened" with salt. At this stage it is important to adjust the quantity of salt carefully. The soap is made just to open so that the homogeneity of the mass may be lost and the separated lye visible from above. But the soap must not be allowed to be unduly grained. The pan is then removed from the fire and allowed to rest for several hours. The half-spent lye settles at the bottom of the pan and can be withdrawn.. This can be utilized for saponifying poorer quality of soaps, the details of which follow at the end of this chapter.

FITTING.

The soap has now been freed from the presence of unsaponified fat but the excess of alkali in it is now to be got rid of. This is done by *fitting.*

The soap is again boiled and water is added until the desired degree of closing is attained. As the water is thoroughly mixed throughout the mass, the thick paste gradually becomes reduced to a smooth thin consistence. Samples are tested from time to time; the thin layer should drop off a hot trowel held sideways in two or three flakes and leave the surface of the trowel clean and dry. If too much water has been mixed with the soap and too fine *fit* is produced which would be denoted by the layer of soap not leaving the trowel, a little caustic lye or brine may be very carefully added and the whole well boiled until the desired condition is obtained. If the soap is properly fitted, all the impurities will be precipitated on standing and the settled soap, containing the correct amount of water, will look clear and bright.

SETTLING.

The fitted soap is then covered up to keep the heat and allowed to stand for 1 or 2 days according to the size of the charge. No covering is needed when the atmospheric temperature is already high. During this settling the contents of the pan separate into three layers, the top consisting of good molten soap (*neat soap or goods*), the intermediate is a slimy soap much richer in water (*nigers*) and the excess or liquor at the bottom. The layer of neat soap has at its topmost portion much frothy substance which is skimmed off first. Neat soap is then taken up and placed in frames to cool and solidify. The nigers are run into another pan to be further treated.

The composition of the three layers is as follows:—

	Water	Anhydrous Soap	Salt and free Alkali.
Top layer (Neat Soap)	30 to 35 p.c.	63 to 69 p.c.	0.5 to 1
Intermediate layer (Nigers)	55 to 65 p.c.	35 to 45 p.c.	1.5 to 3.0 p.c.
Under layer (Liquors)	95 to 97 p.c.	nil	3.0 to 5.0 p.c.

If filling agents, colour and perfumes are to be incorporated in the soap, these are to be crutched in or mixed with agitation into the body of soap before it is put in the frame to cool. The cooled soap is then trimmed for the market. The principles of making toilet and other soaps will be found in their place.

MODIFIED BOILING PROCESS.

The following method of manufacturing soap, based on the German method of soap boiling, is suggested in a Bulletin published by the Department of Industries, Bengal. The time of boiling in this case is considerably shortened.

The process consists in the use of a considerable excess of caustic soda in a fairly strong solution, to initiate the reactions, the speed of which is maintained undiminished to the last by the caustic soda which is always present in excess of the consumable quantity. A general description of the process is given below:—

A strong caustic soda lye is taken in a soap boiling pan. The exact strength and volume of the lye will depend on the proportions and combining weights of the different oils and fats making up a charge. It has been found that for charges containing small proportions only of coconut oil, the proportion of caustic soda should be 23 per cent. of the entire charge of oils and fats. For charges with high proportions of coconut oil the caustic strength should be raised up to 28 per cent. Heat should be applied to the pan after the caustic soda lye has been run in, and as soon as the latter commences boiling the mixture of oils and fats is added, preferably in a thin stream or a spray, so that the contents of the pan may not go off the boil. The strength of the lye has an important bearing on the speed of the reaction. The best results are obtained with a concentration in which the oils, immediately on addition, break up with much swelling into minute globules and the saponification proceeds immediately with extreme rapidity. A too strong lye causes the oil to grain out at once, the grains enclosing much unsaponified oil, while with a weak lye no swelling takes place and therefore the action is less brisk. The strength of the lye should be found out for each type of soap charge with the help of the above indications. In a very short time, the charge is practically completely saponified. At the end of the boiling, the soap is separated from the lye by allowing the latter to run off through the outlet at the bottom of the pan.

The pan should, however, have outlets for soap and spent liquor, and since in the case of application of direct heat an outlet at the centre of the bottom has a short life of efficient service, the pan may be made a rectangular one with a flat bottom and a protruding corner, at the end of which the outlet pipe is to be fitted well outside the zone of direct heat. Where steam is to be used for soap boiling, the pan may be made of the usual design.

The partly spent lye withdrawn from the soap boiling pan will still contain much caustic soda of a fairly high strength to saponify a further charge of oils and fats. In a separate pan this part-spent caustic lye is treated with a fresh batch of oils and fats. The object being the recovery of the alkali, complete saponification is not aimed at. Oils and fats in quantities in excess of those completely saponifiable by the alkali present in this lye are added in order that the entire quantity of the alkali may be taken up. The alkali, still of a fairly high strength, attacks the oils at once and is used up in a short time. When no more free alkali is left, as ascertained by the tongue test or by any other test, the partly saponified charge is separated by means of salt. This partly saponified charge is returned to the first pan towards the end of the saponification of a fresh charge of oils and fats, so that the final product may be a completely saponified soap. The operations may thus be carried on in a cycle.

An alternative way of using the part-spent caustic lye is to add to it only such a quantity of oils and fats as can be completely saponified by the caustic soda present in it, allowing for a very slight excess of the alkali to be left free in the end to ensure complete saponification.

ADVANTAGES OF THE METHOD.

The following are the special advantages of the new method :—

(i) The saponification begins and ends in a strongly caustic medium which always keeps the soap separate from the lye. The impurities disengaged from the oil during boiling have therefore little chance of returning to the soap mass. The result is that more decolorisation and deodorisation take place than are practicable by the use of dilute caustic lyes according to the usual processes.

(ii) The process being a continuous one, the spent lye is not rejected until it has been made to give up all the caustic alkali contained in it. There is no wastage of caustic soda and the cost of production of the soap is, therefore, lowered.

(iii) The time taken to complete the saponification of any charge is considerably shortened, a saving in fuel and labour being the result.

(iv) Direct heated pans may be used, and of as large a size as desired, since no risk of overheating is involved and therefore no stirring arrangement is required, the soap getting no chance to touch the bottom of the pan. In fact, the entire daily charge for a soap factory, however big, can be saponified in a single pan of as large a size as required, the furnace being provided with a suitably large fireplace with as many fire-doors as necessary.

(v) The necessity of repeating again and again the tedious process of boiling on strength in the manufacture of superior soaps, as in the settling process, may be entirely dispensed with, the necessary completeness of saponification being obtained by one boil, or at the most two, in strong caustic lye.

UTILISATION OF SALTED LYE.

The following methods of utilising salted lye after the separation of the soap are taken from a Bulletin published by the Department of Industries, Bengal.

The salted lye after the separation of the soap contains varying degrees of free caustic. To recover it the lye is to be added to the next charge of oils and fats and the quantities should be so regulated that the stock would remain in an emulsified condition and must not merely float on the lye. The mixture should then be heated and the reaction would thereby be accelerated and the taking up of free caustic completed. For the final separation of the stock mixture a quantity of completely spent lye of a previous charge may be added instead of fresh salt till the separation of the slimy soap is complete. The lye which contains no caustic can be thrown away or stored up for the salting of other similar charges. By this process, the stock becomes saponified to a certain extent and much colouring and odorous matter are eliminated. The partly saponified stock is to be next taken up for regular saponification and salting, resulting in a very pale soap containing very little or no odour, depending on the nature of the stock mixture.

If it is found that the spent lye coming from the saponification charges contains too little caustic to saponify the charge to a sufficient extent so as not to allow any oil to separate, a little free caustic may be added, care being taken not to go so far beyond the emulsification point as to cause the separation of oil and soap. By the addition of an excess, the reaction will be hindered greatly and much more time will be taken to bring about the complete recovery of the caustic.

Another way in which the lye can be utilised will be as follows : In factory practice, spent lyes of different charges frequently await reaction till the next day or so. When such cases arise, it is best not to allow the lye to cool but to put it directly into fresh stock for emulsification so that the reaction may proceed overnight with the heat of the lye and the final reaction completed on the following day in the least possibble time with very little expenditure on fuel. A further reduction in the cost of production can thus be effected.

USING THE SILICATE OF SODA.

Mention may here be made that the soap is often given a charge of silicate of soda or washing soda to give firmness to the soap body especially that containing rosin. The methods of incorporating them follow :—

Before the silicate of soda is used in the soap stock, it should be dissolved in hot water. It should be noted that the silicate is sparingly soluble in cold water and settles down in the bottom in that case. The strength of the silicate solution should not exceed 40° Be. As a general rule by mixing equal parts of water and silicate a strength equal to 40° Be is obtained. To get lesser strengths the proportion of water should be increased.

While soap is being made by cold process, it should be the practice of the manufacturers, to add the silicate in solution when the oil and the lye are well mixed. Brisk agitation is essential during the mixing operation; otherwise, the stock is liable to set in places and to present lumps in its body which is most undesirable.

During manufacturing of soap by the boiling process, the silicate should be poured in when the saponification is completed and the stock is yet of a thin consistency. Both the soap stock and the silicate solution should be hot before they are mixed together. Vigorous stirring is to be made during mixing with wooden poles, otherwise lumps are liable to form within the mass of the soap. Sodium silicate usually requires one-fifth its weight of caustic soda of 38°Be for action.

Silicate of soda may also be added to the oil in some cases before it is treated by caustic soda for saponification.

USING SODA ASH.

The soda ash may be added in a powdery form when the saponification is nearing completion or in the form of a lye dissolved in water while the saponification is still going on. In the first case water is generally added to the soap to thin it down before the addition of the solid while in the latter case the usual proportion of soda ash and water is 1 to 2.

Care should be taken not to add strong soda ash solution to a firm soap because this renders the soap brittle. This can be added to weak soaps only because this enables the soap to carry more water than pure soap. Usually strengths of the solution should be 16° to 34° Be.

Soda crystals may be melted direct on fire. These give a solution which can be added to hot soaps provided it is weak-bodied or thinned down by the addition of water.

When pearl ash is used, a solution of 2½° to 5°Be is to be preferred.

Reference may in this connection be made to Liquoring of Soap in Chapter V.

HARDNESS OF SOAP.

In conclusion it may be pointed out that selection of the soap stock has much to do with the hardness or softness of soap. It may be known that oils have got different hardness number, and the soaps made from them are firm or soft in texture in order of their hardness number. The following table shows the hardness number of different oils:—

	Hardness Number
Coconut Oil	333.2
Tallow	327.6
Rosin	316.4
Mohua Oil	276.0
Punnal Oil	227.1
Karanja Oil	208.8
Cotton Seed Oil	205.6
Groundnut Oil	196.3
Fish Oil	172.6
Sesamum Oil	170.1
Mustard Oil	119.4
Castor Oil	107.6
Linseed Oil	70.5

Usually oils with higher hardness number give soaps of higher consistency. Only castor oil gives softer soap than what is indicated by the hardness number on account of the presence in it of hydroxy-acids, e.g., ricinoleic, iso-ricinoleic and dihydroxy stearic acids. The hardness number of any soap stock can be found out from the above table in the following manner :—

Suppose a soap stock consists of groundnut oil 40 per cent., linseed oil 20 per cent., cotton seed oil 20 per cent., and tallow 20 per cent. The hardness number of the stock is calculated thus:—

		Parts	Number Hardness
Groundnut Oil	--	40	× 196.3 = 7,852
Linseed Oil	--	20	× 70.5 = 1,410
Cotton Seed Oil	--	20	× 205.6 = 4,112
Tallow	--	20	× 327.6 = 6,552
TOTAL		100	19,926

Hardness Number of this blend is given by $\frac{19926}{100}$ 199.3.

Hardness number of other blends may be found out in the above manner.

It may be noted that the hardness number of soap stocks for soft soaps ranges from 125 to 150, except in cases of charges having castor oil as a constituent when it should come to about 175. Hardness number of soap stock for washing soaps should be above 250.

CHAPTER IV.

FACTORY EQUIPMENTS.

AMONG the special equipments of a factory may be mentioned the furnace, the kettle, the frames, the slabbing, barring and stamping machines. But when business is sought to be done on a big scale, there should be in addition to these appliances various other machines such as crutchers, scrapers, remelters, mixers, crushers, soap drying chamber, etc., etc.

FURNACE.

The first requisite in the manufacture of soap is the construction of the furnace, the size of which would depend upon the size of the boiling pan and the quantity of stock to be treated in a single batch. A raised platform is constructed of brick with an opening in the middle to serve as the top of the furnace. The platform is supported by a number of pillars so that there may be a narrow open space leading slantingly upwards to the opening. The fireplace is made at one side, at the extremity of this passage. Iron gratings are placed for proper airing. The ash pit is left just below the gratings. The mouth of the furnace is provided with a suitable dumper. On the side opposite the fireplace there is a chimney connected with the central opening for the escape of the smoke. The operators can take their stand on the platform and work the mass. If the pan be very high, stools or ladder may be provided for the purpose.

Either coal or fuel is fed into the fireplace over the gratings and set fire to. The flame does not directly heat the pan which tightly fits the opening of the furnace. The flame is carried along the narrow alley provided for the purpose and heats the contents of the pan. The dumper is adjusted for proper circulation of air into the furnace.

The furnace should permit of the regulation of heat with ease. In the furnace just described, this can be achieved without much difficulty. When the temperature is wanted to be raised, more coal or fuel may be charged into the furnace and extent of the air hole may be increased so that more air can pass and help the vigorous burning of the combustible material. When a lower temperature is desired, the size of the air hole may be diminished with the result that the burning of the combustible substances slows down appreciably. If the furnace is charged with fuel, some of it may also be drawn out while in the case of coal furnace ashes may be spread over the coal for immediate reduction of temperature.

Ordinary furnaces for heating purposes are quite sufficient for the boiling of soap but in modern factories where large masses of soap stock are to be treated the furnace is altogether done away with. The heating is done with steam which is made to pass through closed or open pipes through the mass of the soap stock. This not only facilitates the equal heating of the entire mass but also prevents charring of the mass just in contact with the bottom of the pan. The injection of live steam within the mass of the soap helps saponification and closing of the soap.

SOAP KETTLES.

Soap is ordinarily boiled in open wrought iron pans made up in one piece. But when large masses of soaps are to be treated at the same time, the pan is made of several pieces riveted together firmly. It somewhat resembles the cauldrons of the confectioners in shape but is much bigger and deeper, the depth being more

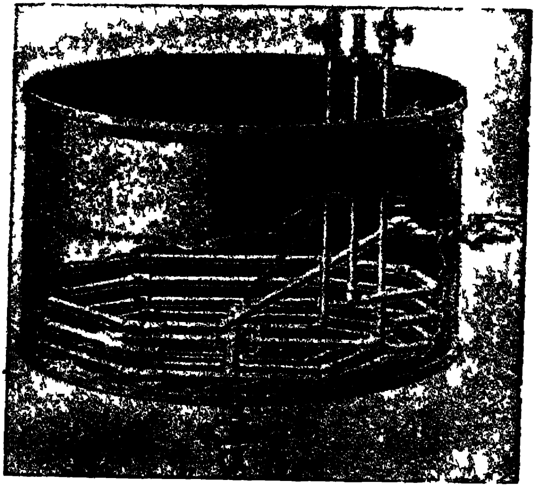

FIG 1. Section of a Soap Kettle

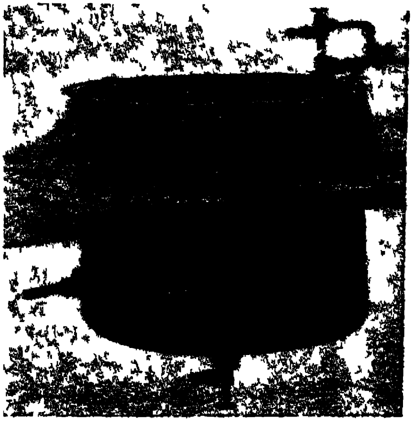

FIG. 2. Soap Boiler for Direct Steam Heating.

than the diameter. Usually a cubical content of 5 maunds has to be allowed for every maund of oil and fat to be treated at a time. For example, if 6 maunds of soap is to be boiled the capacity of the pan should be 30 maunds. This allowance is made as soap is liable to froth up tremendously during boiling and would otherwise flow over and may even end in accidents.

In big factories the ordinary boiling pans are replaced by soap kettles, which are provided with coils all through the volume of the kettle. Steam from the boilers is made to circulate through the coils. In common pans heated from below the contents are not heated equally, mainly because the soap is a non-conductor of heat. But in the soap kettles with several sets of coils arranged systematically the equal heating of the entire mass may be easily assured.

SOAP FRAMES.

Soap frames are essentially nothing but big and narrow rectangular boxes with removable sides and are intended for the cooling of the finished soap, to be subsequently slabbed, barred and stamped. These may be constructed either of wood or of iron sheet or galvanised sheets but in every case care should be exercised that the sides permit of being removed or built up whenever necessary without the least difficulty or delay and the cooling proceeds gradually without any leakage of soap whatsoever. The shape and size of the frames depend upon the rate of cooling most congenial for the manufacture of a particular type of soap and vary in each case according to the requirements of each individual case. If the cooling is to be hastened the extent of the surface exposed should be fairly large and sheets should be rather thin while in cases where the heat is to be conserved for a long time the surface exposed should be comparatively small, the thickness of the side plates should be great and the thermal con-

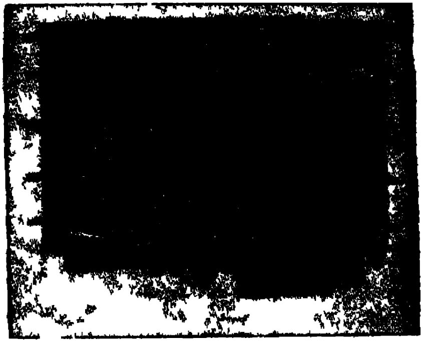

FIG. 3 Soap Frames with Screw Clamps

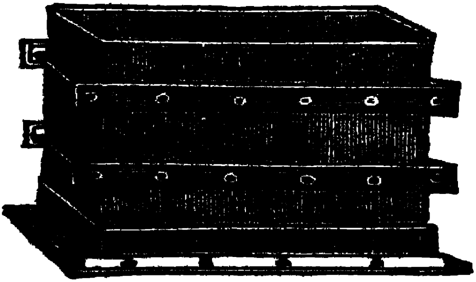

FIG. 4. Soap Frame.

ductivity of the material making up the plates should be low. For example, soap in a box made of wood would cool more slowly than in an exactly equally made box of galvanised sheet. Another point to be considered is the lateral pressure of the soap. The strength of the plates should be sufficient to counterpoise it and the thickness should not be so small that the plate would give way. The most common size is, however, 45 inches long, 15 inches wide and 45 inches deep but boxes of other sizes are also called into requisition.

The wooden soap frames are rarely made of single planks on each side. A number of stout frames of wooden beams, the sides fitting tightly into grooves, may be constructed, each being of the same internal dimension and an approximate height of 3 to 5 inches. They are placed one upon the other when a big-shaped rectangular frame will be automatically formed. But the frames not being rigidly connected with one another are very apt to be deflected from the normal position. Hence a number of rods are passed through the four corners and along the sides vertically down through the beams and are tightly screwed to keep all the individual frames rigidly fixed in position. The rods should be capable of being removed easily whenever necessary and the several parts may be unloosened from one another. The wooden frames are now out-of-date and are used only during the manufacture of mottled and cold process soaps.

The soap frames used in modern factories are generally made of galvanised iron sheets in the shape of narrow high boxes. They have a stout wooden base which is mounted on wheels and can thus be carried from place to place without difficulty. All round the base are vertically erected wrought or cast iron sheets so fixed as to make a rectangular box of the dimensions 45″ × 15″ × 45″. To keep the plates vertically fixed against pressure from within, these are tightened by means of clamps which are easily worked. In certain forms of the frames the portions of the sides are prolonged into lugs containing holes through which the rods are made to pass, binding the ends of frames against the sides, the ends of the rods being secured by screw nuts. In some patterns of soap frames the ends of the frame are made to fit into grooves in the sides making as tight a joint as possible.

The soap frame has a removable cover which can be put in when the soap has been run into the frames. Weights placed on the lid give better results regarding the graining of soap.

SLABBING MACHINE.

The soap emerges from the soap frame in the shape of huge rectangular blocks which after scraping and trimming are ready to be slabbed and then cut into bars. The slabbing operation can be performed with a long piece of steel wire provided with huge handles at the two ends. The block is first marked all round by a scribe to divide it into a number of slabs of uniform thickness. The wire is then placed just over the mark and then drawn through. This separates a slab from the main block. The drawing operation may then be repeated to cut the whole block into slabs.

Slabbing machines based on the principle just enumerated are available in the market. A frame containing horizontal wires placed at equal distances apart makes up the cutting arrangement and this can be drawn in uniformly by means of chains and windlass or the block can be mechanically pushed through the frame of equidistant wires.

BARRING MACHINES.

The slabs of soaps are next cut into uniform bars with barring machines of which there are several types

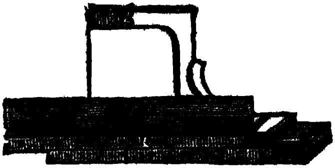

FIG 5. Soap Cutting Machine

FIG. 6. Slabbing Machine

FIG. 7. Barring Machine.

available in the market. Essentially the machine consists of an upright frame with fixed wires adjustable at suitable distances apart. The slab is placed on the table while the frame is made to hang overhead. By suitable adjustments the frame is let go and in falling down it cuts through the slab dividing it into bars. Any scrapings formed during cutting are collected into a drawer below and may be re-used. The barring machines may be employed in cutting the bars into pieces as desired by adjusting the distance of the wires.

Modern machines of improved types have been invented to cut the slabs of soaps into bars and the bars into pieces by one and the same operation.

STAMPING MACHINES.

Bar soaps are now out of date; the pieces are generally decently stamped with the names of the manufacturers on one side and trade marks on the other.

The stamping operation can be done with hand machines of which the most important part is the die for pressing the soap in. By changing the die various designs can be imprinted on the tablets. The die consists of two halves and are from time to time moistened with a little salt water or glycerine to overcome stickiness. The soap is sometimes made into a double cake, joined side-ways or a single cake as desired. Several types of stamping machines have arrangements for pressing all the sides up and forming a mould. In such cases when the tablet has been formed, the sides fall down to the original position but the tablet is left there to be removed by hand before giving the second piece to be similarly punched.

Of late years stamping machines worked by foot have been put in the market. The great advantage of the machine is that both the hands of the operator

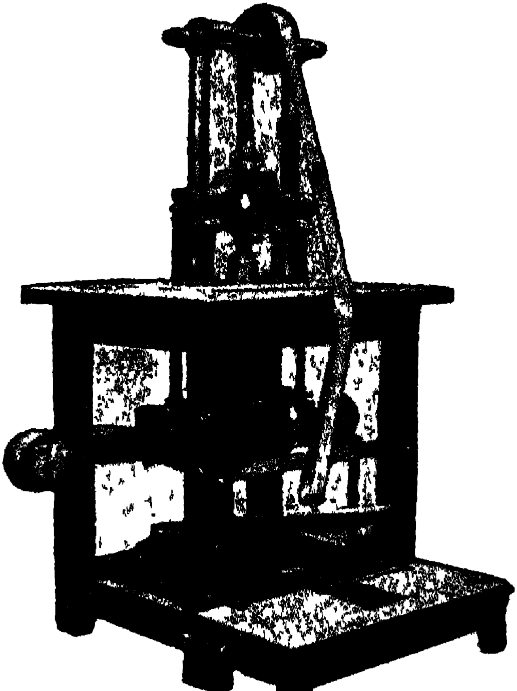

FIG. 8. Soap Stamping Machine.

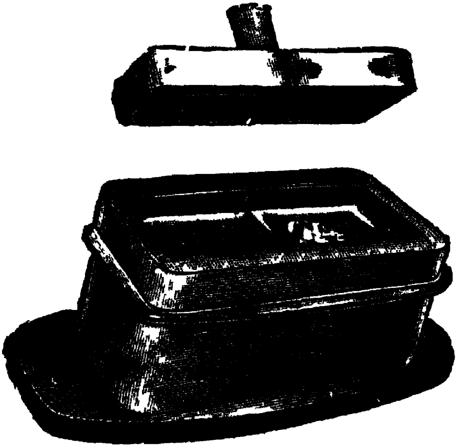

Fig 9 Soap Dies.

Fig. 10. Automatic Soap Press.

are free for placing and removing the cakes of soap. The force necessary for stamping a cake is derived from the swing of the pendulum which only has to be set in motion. Sometimes provision is made for counter weights in order to bring back easily and quickly the upper stamp to its starting position.

CHIPPING MACHINES FOR SOAP BARS.

The soap chipper is intended for reducing the soap bars to shavings. It consists essentially of vertical rotating discs, fastened to an iron frame and carries a number of plain and toothed knives fixed in slits. The bar placed in the feed channel presses against the disc, the slightly projecting knives of which cut shavings off from the front side. The knives are adjustable and can thus be made to produce shavings of different thickness which are caught in a box placed underneath. Some shaving machines are also made in such a way that the knives can be easily and quickly removed either for cleaning or adjustment to any thickness of shavings desired. This can be done by lifting up the front side of the box.

SOAP DRYING MACHINES.

To dry the soap shavings these are placed on trays which are again filled into racks. The racks are then placed in a room heated by steam pipes. When the amount of water is between 15 to 10 per cent., the drying operation is stopped. Elaborate machines for the purpose are also available.

SOAP MIXER.

Mixing machines are intended for mixing the dried soap shavings from the chipping machine with colours and perfumes. It has a cylindrical tub provided with a cover on the upper open side to close the vessel hermetically when it is in action. An axle runs through

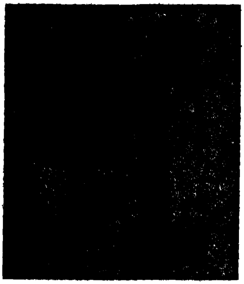

FIG. 11. Soap Chipping Machine.

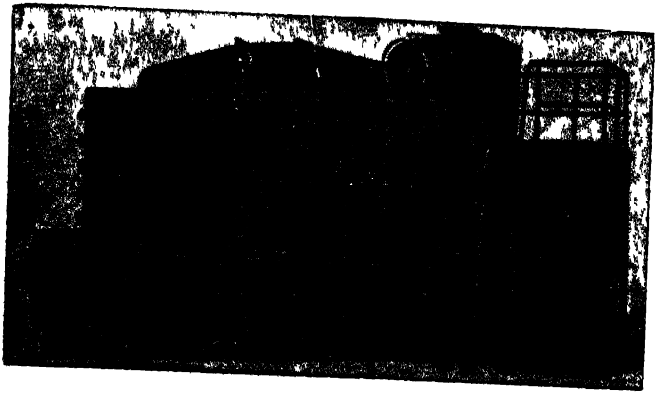

FIG. 12. Soap Drying Chamber.

the middle of the tub to which paddles are fixed. This is made to revolve by suitable gearing and the motion of the paddles causes the soap to become mixed and form a homogeneous mass. Crutching is necessary when filling the washing soap with silicates or in perfuming and colouring toilet soaps.

SOAP CRUSHER.

Soap crushers are intended for crushing the dried soap shavings and incorporating scents and colours when milling the soap thoroughly. The machine is provided with a number of rollers made of polished and veinless granite. The roller can be adjusted according to the fineness of the spans by means of an adjustable device of the first and third rollers against the second (middle) roller. There are two hoppers in the machine. The shavings fed into the lower hopper travel between the rollers and occupy the top hopper. A steel or wooden comb is used to scrape the hopper and the mixture is again allowed to drop into the lower hopper by taking off the side. When the soap is crushed fine, colours and perfumes are added and the process is repeated three or four times when a homogeneous mass is obtained.

SQUEEZING MACHINE (SCREW PLODDER).

The plodder is a machine which compresses the coloured and perfumed soap after being milled into a solid compact mass and then ejects it in the form of a bar which is divided into cakes of the desired size. Machines of various construction are employed for this purpose; however, every one corresponds in its essential parts with the others. Usually the machine rests upon a firmly mounted frame and consists of a hollow cylinder provided with a hopper. The cylinder contains a screw-shaft turned by an arrangement of cog-wheels. The forepart of the cylinder is conical in shape and

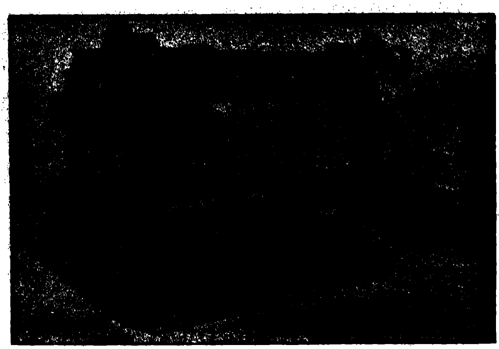

FIG. 13. Soap Rubbing Machine.

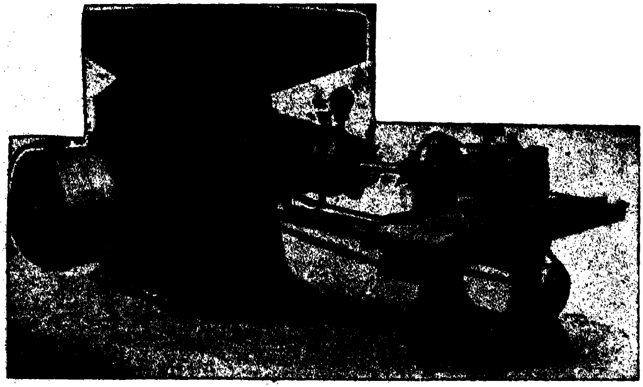

FIG. 14. Screw Plodder.

has double walls at the end for heating and cooling purposes. At the end of the front cone there is an arrangement by which the soap is delivered. A roller feeds the worm in a perfectly uniform, automatic and safe manner. The feed hopper is very large, so that it can take very considerable quantities of soap and any recharging or pushing forward of the charge of the soap by hand is thereby done away with.

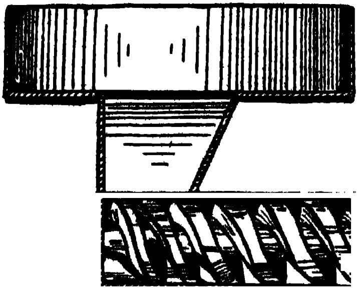

FIG. 15. Section of Screw Plodder.

DISINTEGRATORS.

In making soap powders, use is made by soap makers of disintegrators. These are of inestimable value in powdering dried chips of soap and save much manual labour. It also breaks the lumps which occur in soap powders.

APPLIANCES.

A number of other appliances is required for soap making. The chief among them are a long wooden stirrer, an iron scratcher to scratch the soap adhering to the sides of the vessel, trowel, iron tanks for lye making, toothed gauging sticks, hydrometers, etc., etc.

CHAPTER V.

PRELIMINARY OPERATIONS IN SOAP MAKING.

THE principles of the manufacture of soap have already been given but for success in manufacture the soap boilers have to follow a regular scheme of work and to adhere to only correct manipulations. Preliminary operations in soap making follow :—

SOFTENING WATER.

The first point demanding the attention of the manufacturer is the purification of the raw materials he uses during manufacture. He has to examine whether the water available in the factory is soft or hard, *i.e.*, whether it lathers readily with soap or not. If the water be what is chemically designated as soft, *i.e.*, if it produces lather with soap readily, no preliminary treatment is to be undergone; but when it is not so, special treatment is necessary to prevent much waste of soap during manufacture due to deposition of scum.

To soften water the degree of hardness is to be first ascertained by experiments. Then lime water and sodium carbonate are added to the water in proper proportions to rectify the hardness. The water is then boiled. For detailed process reference may be made to any text book of Chemistry.

REFINING OF TALLOW.

Indian cattle being more often than not lean and underfed, the tallow obtained in this country is of poor quality. Moreover, the commercial grades of tallow are often adulterated and fail to give good quality soap. The process of refining tallow is given in Bulletin No. 30 published by the Department of Industries, *Bengal, which is reproduced here for the efficacy and* simplicity of the process.

The crude tallow is melted in a deep iron pan in which a quantity of water, about equal in quantity to the tallow to be refined, is added. The pan is better provided with cocks at different levels for the drawing off of the melted tallow. On heating the pan, the water begins to boil and the tallow floats on the surface of the water as a layer. The whole thing is boiled for about an hour with frequent stirring of the mass. During this operation, all the impurities of the tallow are taken up by the water including dirt and also particles of flesh and blood. Heating is then stopped and the tallow floating at the top as a clear layer is either syphoned off or drawn off through decanting cocks and allowed to solidify in separate vessels. The last portions of the tallow, however, remains at the top grazing the surface of the water and cannot be drawn off. On allowing the whole thing to cool, the last portions of the tallow solidify as a crust and much of the impurities adhere to the bottom of the crust. The solid crust is taken out and the impurities scraped and returned to the pan. The solid crust, if not pure enough, may be added in a subsequent charge for purification.

The water in the pan consists of much tallow mixed with impurities and is treated as follows :—Heavy particles of flesh are taken out by means of a perforated ladle as these consume a large quantity of chemicals and interfere with the recovery of the tallow as soap, but the sinews are not to be removed as they contain a certain quantity of combined tallow. Caustic soda solution is then added gradually and the mass boiled, when the sinews and the minute particles of flesh dissolve and the tallow becomes saponified with the formation of soap. The boiling is continued with the addition of caustic soda till the alkali persists which can be readily ascertained by testing the solution on the tongue. A biting sensation indicates that the alkali is in excess. During the process all the tallow contained in the water used for the purification becomes saponified with the formation of soap. The flesh and blood particles dissolve with the formation of glue.

The solution thus becomes free from all sorts of impurities and is next boiled to a thick consistency. Salt is gradually added to induce the separation of soap. During the addition of salt the boiling is continued and the separation of soap at the top is noted before each addition of salt. As soon as the soap begins to collect at the surface, the addition of salt is discontinued and the mass is boiled for some time to allow all the soap to separate on the surface. When all the soap formed has separated, the mass is allowed to cool.

As the stock is set aside to settle and cool, the soap solidifies at the top as a solid crust. The soap thus separated is free from solid impurities which remain behind in the lye, but the soap being separated from a glue solution is not suitable for being moulded or made into frame soaps or worked up with fresh charges of soap as it still contains much soluble impurities. To further purify this, the soap is dissolved in a small quantity of water and separated again with the addition of salt when most of the soluble impurities of the soap remains behind in the lye. The soap after the second salting, though not suitable for direct moulding or forming into frame soap, can be worked with fresh charges of soap in a soap factory. The recovered soap from the impurities may with advantage be used for inferior batches of soap, if so desired, using the refined tallow for only first class soaps.

NECESSITY FOR REFINING OIL.

Almost all sorts of oils are fitted for being made into soaps but to attain a high excellence of the products it is only proper that only the unadulterated oils should be used.

Presence of impurities in the oil, e.g., the dissolved colouring matters, free fatty acids and other undesirable ingredients seriously affect the colour, odour, appearance and keeping qualities of the soap. The presence of dust, earth, sticks, etc. in the oil is not very much injurious as they are drawn out along with glycerine during the graining process. But it is quite otherwise when the oil is to be treated by the cold process. In such cases at least the sticks and solid matters must be eliminated by allowing the oil to settle for some time, otherwise they would mar the soap.

It is also to be noted at the outset that if the colouring matters present in the oil are not removed prior to boiling the oil for saponification, the final product will develop a dark and dirty colour which is to be particularly avoided. Deodorisation of the foul-smelling oils is of the greatest moment. If this is not properly done the soap will emit a most unpleasant odour which will verily go against it during marketing the stock.

Of course with the employment of fresh and high grade oils these bleaching and deodorising operations may be dispensed with but the cost of the stock will in that circumstance be rather high. The manufacturers have, however, found it profitable to use a certain percentage of cheap oils in their soap stocks. By refining these oils in their factory they can further increase the percentage of the low-priced oils in their soap stocks without appreciably lowering the quality of the soap.

PURIFICATION OF OILS AND FATS.

The following method of refining oils and fats for soap makers' use is gathered from a Bulletin published by the Department of Industries, Bengal.

PURIFICATION WITH WATER.

The oil or fat to be purified is to be taken in a round-bottom iron pan of a size suitable for the quantity of stock to be dealt with, the oil or fat filling up to nearly half the pan. Water of a volume equal to that of the oil should then be run into the pan. The little empty space left in the pan will be enough for the boiling, as there will be no fear of the contents swelling up like soap. The oil or fat being lighter, floats on the water. The contents of the pan are next boiled for one to two hours depending on the quantity of impurities present in the original oil or fat.

No harm is done by heating the pan over direct fire, because the oil forms the upper layer and never comes in contact with the bottom of the pan. In some cases, however, a little froth is noticed. The boiling should in such cases be continued until the froth disappears. It is essential that a state of brisk boiling be maintained during the process. The agitation of the contents caused by ebullition is more helpful than any mechanical stirring device in bringing all the oil and water in repeated close contacts. The treatment leaves the oil in a condition in which it can quickly settle the impurities.

On the conclusion of boiling process as explained, the pan is left undisturbed for a sufficiently long time to allow of proper settling of impurities. The clear oil collects at the top and all the mucilagenous matter is found collected in a layer of emulsified oil between the clear oil and the water. After the settling of the impurities, the supernatant clear oil is taken off, leaving the layer of emulsified oil. If the oil has a chance to solidify on cooling, it has to be removed while still hot, or it may be allowed to solidify and the impurities that will be found in the bottom side scraped off.

RECOVERY OF OIL FROM EMULSIFIED LAYER.

The thickness of the emulsified layer depends on the nature of the oil. Coconut oil and tallow, for example, do not, for all practical purposes, emulsify, while linseed oil emulsifies very readily. Mowha and *karanja* oils have intermediate emulsifying powers, the latter surpassing the former. Linseed oil which emulsifies readily takes long to separate into oil and water again. When, therefore, such oils are treated according to the method just described, considerable quantities of the oil are held by the emulsion from which it separates out only very slowly. The purification process is thus made a very lengthy one and it is therefore not advisable to treat them singly. In admixture with coconut oil and tallow, however, they have been found to separate readily. It is therefore recommended that the oils, with high emulsifying powers should, for the purpose of purification, be mixed with oils with low emulsifying powers.

The emulsified layer, containing the mucilagenous and other light impurities, is filtered through cloth. The filtrate consisting of a clean mixture of oil and water is added to the next charge, the impurities being separated and retained by the filtering cloth. It will thus be seen that no oil will be wanted in the process of refining, the impurities being the only thing eliminated.

The purification of the oil by the above process should be undertaken as and when the oil is required for saponification. If much time is allowed to elapse between the purification and the saponification, the perfect oil may develop a fresh objectionable odour without redeveloping colour.

PURIFICATION WITH SPENT LYE.

For oils which have a bad odour with or without an objectionable colour, the course of treatment with boiling water is not enough. The oil or fat is to be boiled over the spent liquor obtained on salting a pan. It is essential that the spent liquor should contain enough salt to prevent the stock to be purified from forming an emulsion with the lye, or the dissolving, in the latter, of any soap which is formed as a result of the partial saponification of the stock with the caustic soda present in the spent lye. This process removes the odour to a great extent, unless the same is present in an excessive amount in which case a more rigorous treatment will be necessary.

PURIFICATION WITH CAUSTIC SODA.

When the stock contains much odour and colouring matters associated with resinous bodies, the simple boiling over spent lye containing a little free caustic soda will not meet the end. Examples of such cases are neem oil and grease from bones. In these cases the stock is to be added to the spent lye and boiled to nearly complete saponification. This necessitates the addition to the spent lye of just enough oil or fat which can be saponified by the free alkali present in it. It is sometimes an advantage to supplement the caustic originally present in the spent lye with fresh caustic to get through a larger quantity of oils and fats and to utilize the lye medium for the elimination of as much colouring and odorous matters as possible.

When the saponification proceeds over the spent lye, the oil medium carrying the odours and colouring matters is converted into soap with the result that the colouring matter is disengaged and discharged into the lye and the odorous matter escapes along with the steam. The oil thus purified and converted into soap is next added to the main soap charge for the production of high grade soaps consistently with the general quality of the raw material and without any of the disabilities due to the colouring and odorous matters.

As the process entails the boiling of large quantities of lye for the treatment of limited quantities of soap stock, the operation is best carried on economically in shallow pans over the flues of regular soap-boiling furnaces. It will be seen that the heat that is usually wasted will be utilized in the recovery of all the caustic soda in the spent lye and at the same time in purifying, or treating up to saponification, very inferior stocks and making them suitable for good quality soaps.

BLEACHING THE OIL.

The fact is that the colouring matter in the original seed is in the form of a powder and passes as such into the oil. It can therefore be bleached by allowing it to pass through a percolator charged with animal charcoal which absorbs the colouring matters. A similar object is achieved by dehydrating the colouring matter with sulphuric acid, which causes the colouring matters to get charred and to coagulate. The acid is added gradually-as long as there is a change of colour. Then the oil mass is heated. The charred masses can then be removed by filtration. Care should be taken that the acid may not be added in excess, in which case the consumption of caustic soda will obviously be bigger.

DEODORISING THE OIL.

Where the retention of the characteristic flavour of an oil is not desired, the oil is first heated to a temperature higher than the boiling point of water and is further treated in what is called a deodoriser. Oils intended to be treated in this way should be as nearly neutral as possible, as oils showing excess of acidity cannot be satisfactorily treated.

Deodorisers, intended for soap factories, may be either of atmospheric or vacuum type. In the former type the oil is subjected to the heat of both closed and open steam coils. The former raises the temperature of the oil to that of the steam, while the latter keeps the oil in an exceedingly vigorous state of ebullition so that the unpleasant odours escape into the atmosphere.

In the vacuum type of deodorisers, the oil is similarly treated but at reduced temperatures and pressures, and in consequence there is less likelihood of damage to the oil.

MAKING CAUSTIC LYE.

Lyes for soap making are prepared by dissolving in water the solid caustic hydroxides. The commercial caustic soda is usually supplied in large drums which require to be broken open before the caustic, they contain, can be dissolved. This caustic is dissolved in iron tanks with a suitable quantity of water. The correct way of doing this is to suspend the solid caustic at the top of the tank just underneath the surface of the water used to dissolve it; then the lye as it is formed, being heavier than the surrounding water, sinks to the bottom, so that the solid caustic, by reason of the currents thus set up, is always coming in contact with fresh water or unsaturated lye, and consequently soon becomes dissolved. This may be carried out by placing a perforated iron plate just under the surface of the water or liquor in the tanks. The solid caustic may be broken out of the drums and thrown on it.

Caustic soda lyes should not be kept too long exposed to the atmosphere, as they tend to absorb carbonic acid and pass into carbonate of soda, the alkaline or soap-making strength being thereby reduced. It is better to prepare the lye freshly whenever required.

Soda lyes of any strength may be made from the solid caustic.

CONCENTRATION OF THE LYE.

The concentration of the lye required for saponification varies with the nature of the oil to be treated, as has already been explained on page 38. Strong and weak solutions are both to be made. The strength can either be expressed by mentioning the quantities of the water and the soda in full or by giving the specific gravity or degrees as recorded either by a Twaddle's or Beaume's Hydrometer.

In the first case, i.e., when the proportion of caustic soda and water for making the lye is known there is no difficulty in preparing the solution but the preparation of a solution of a definite specific gravity from the waste lye becomes a difficult operation. In such cases the specific gravity of the waste liquor is to be first determined and then the further quantity to be added is to be calculated out. Considered from all points of view it is more convenient and easy to use the Twaddle's or Beaume's hydrometer. In preparing the lye of a given strength the caustic is added to water little at a time and the lye is then allowed to cool. The hydrometer is to be put into the solution and the mark to which the hydrometer sinks gives the strength of the lye. If greater strength is to be attained, more soda is to be added till the correct reading is obtained. If the strength is already too high, the lye is to be diluted with more water. In each case the lye is allowed to come to normal temperature before any reading is taken by the hydrometer. For soap making, manufacturers should procure a hydrometer meant for liquids heavier than water. The graduations in a Beaume's hydrometer are based on the principle that the point to which the hydrometer sinks in pure water is marked 0° and the point to which it sinks in a 10 per cent. solution of common salt (at 17°C) is marked 10°. One hydrometer graduated 0°—50° will serve the purpose of soap makers.

The approximate quantities of caustic soda to be added to 100 parts of water to obtain lyes of different strengths follow :

Strength of the Lye	*Water*	*Caustic Soda* (77°)
5° Be	100 parts.	3.56
10° Be	100 ,,	7.40
15° Be	100 ,,	11.45
20° Be	100 ,,	16.78
25° Be	100 ,,	22.84
27° Be	100 ,,	26.36
28° Be	100 ,,	27.58
30° Be	100 ,,	31.05
32° Be	100 ,,	34.66
33° Be	100 ,,	36.68
35° Be	100 ,,	41.16
36° Be	100 ,,	43.33
37° Be	100 ,,	45.91
38° Be	100 ,,	48.38
40° Be	100 ,,	54.17
42° Be	100 ,,	60.44
44° Be	100 ,,	67.38
45° Be	100 ..	69.64

RELATION BETWEEN SPECIFIC GRAVITY, DEGREES BEAUME AND TWADDLE.

Two sets of formula showing the relation between specific gravity and the degrees registered by a Twaddle's hydrometer may be found useful.

$$\text{Specific Gravity} = \frac{\text{Degrees Twaddle} \times 5 + 1000}{1000}$$

$$\text{Degrees Twaddle} = \frac{\text{Specific Gravity} \times 1000 - 1000}{5}$$

There is, however, no definite formula establishing the relation between the specific gravity and the Beaume's degrees.

The following table connecting the Twaddle, Beaume and Specific Gravity figures may be found useful for a comparative study of the strengths of the lye expressed in terms of these:—

Degrees Beaume	Degrees Twaddle	Specific Gravity
1	1·4	1·007
2	2·8	1·014
3	4·4	1·022
4	5·8	1·029
5	7·4	1·036
6	9·0	1·045
7	10·4	1·052
8	12·0	1·060
9	13·4	1·067
10	15·0	1·075
11	16·6	1·083
12	18·2	1·091
13	20·0	1·100
14	21·6	1·108
15	23·2	1·116
16	25·0	1·125
17	26·8	1·134
18	28·4	1·142
19	30.4	1·152
20	32·4	1·162
21	34·2	1·171
22	36·0	1·180
23	38·0	1·190
24	40·0	1·200
25	42·0	1·210
26	44·0	1·220
27	46·2	1·231
28	48·2	1·241
29	50·4	1·252
30	52·6	1·263
31	54·8	1·274
32	57·0	1·285

Degrees Beaume	Degrees Twaddle	Specific Gravity
33	59·4	1·297
34	61·6	1·308
35	64·0	1·320
36	66·4	1·332
37	69·0	1·345
38	71·4	1·357
39	74·0	1·370
40	76·6	1·383
41	79·4	1·397
42	82·0	1·410
43	84·8	1·424
44	87·6	1·438
45	90·6	1·453
46	93·6	1·468
47	96·6	1·483
48	99.6	1·498
49	102·8	1·514
50	106·0	1·530
52·4	114·0	1·570
54·7	122·0	1·610
56·9	130·0	1·650
58·9	138·0	1·690
60·9	146·0	1·730
62·8	154·0	1·770
64·6	162·0	1·810
66·3	170·0	1·850
70	189·2	1·946
72	200·0	2·000
74	211·8	2·059

For example, a solution of specific gravity of 1.297 will record a reading of 33° with Beaume's hydrometer and 59.4° with Twaddle hydrometer.

CAUSTIC SODA LYE.

The amount of caustic soda to be dissolved in water to make a certain definite strength is rather a vexing problem; specially this is so when the caustic soda used is not cent per cent. pure. The following table, however, will be much helpful in this respect:—

TABLE OF SPECIFIC GRAVITIES OF SOLUTIONS OF CAUSTIC SODA.

Degrees Twaddle	Specific Gravity	Per cent by wt. of Caustic Soda.	lb. of actual NaOH contained in 1 gall. commercial caustic soda lye.		
			77°	74°	70°
1	1·005	0·474	0·048	0·046	0·043
2	1·010	0·757	0·098	0·092	0·087
3	1·015	1·436	0·146	0·131	0·129
4	1·020	1·909	0·194	0·185	0·180
5	1·025	2·365	0·234	0·231	0·219
6	1·030	2·830	0·291	0·278	0·262
7	1·035	3·252	0·335	0·320	0·303
8	1·040	3·746	0·389	0·371	0·350
9	1·045	4·184	0·438	0·417	0·393
10	1·050	4·631	0·486	0·461	0·438
11	1·055	5·086	0·536	0·510	0·483
12	1·060	5·536	0·586	0·558	0·528
13	1·065	5·982	0·636	0·607	0·573
14	1·070	6·413	0·680	0·653	0·617
15	1·075	6·911	0·742	0·707	0·668
16	1·080	7·285	0·786	0·749	0·709
17	1·085	7·715	0·836	0·798	0·755
18	1·090	8·140	0·886	0·845	0·800
19	1·095	8·564	0·937	0·894	0·846
20	1·100	8·970	0·986	0·941	0·890
21	1·105	9·386	1·037	0·989	0·938
22	1·110	9·796	1·087	1·037	0·981
23	1·115	10·203	1·137	1·123	1·026
24	1·120	10·607	1·187	1·175	1·071
25	1·125	11·107	1·238	1·181	1·117
26	1·130	11·471	1·296	1·237	1·170
27	1·135	11·933	1·354	1·292	1·212
28	1·140	12·401	1·413	1·350	1·277
29	1·145	12·844	1·470	1·413	1·337
30	1·150	13·303	1·529	1·460	1·381
31	1·155	13·859	1·600	1·528	1·445
32	1·160	14·190	1·646	1·541	1·496
33	1·165	14·637	1·705	1·627	1·539
34	1·170	15·081	1·764	1·684	1·593
35	1·175	15·512	1·822	1·739	1·649

Degrees Twaddle	Specific Gravity	Per cent by wt. of Caustic Soda.	℔. of actual NaOH contained in 1 gall. commercial caustic soda lye.		
			77°	74°	70°
36	1·180	16·139	1·904	1·817	1·719
37	1·185	16·372	1·942	1·853	1·753
38	1·190	16·794	1·998	1·887	1·804
39	1·195	17·203	2·055	1·963	1·856
40	1·200	17·629	2·122	2·026	1·916
41	1·205	18·133	2·185	2·085	1·973
42	1·210	18·618	2·252	2·147	2·033
43	1·215	19·121	2·323	2·221	2·097
44	1·220	19·613	2·392	2·280	2·161
45	1·225	19·997	2·444	2·338	2·206
46	1·230	20·586	2·562	2·417	2·285
47	1·235	20 996	2·593	2·475	2·341
48	1·240	21·532	2·669	2·548	2·410
49	1·245	22·008	2·739	2·615	2·474
50	1·250	22·476	2·809	2·681	2·536
51	1·255	22 962	2·881	2·750	2·602
52	1·260	23·433	2 952	2·818	2·666
53	1·265	23·901	3·020	2·886	2·730
54	1·270	24 376	3·095	2·955	2·795
55	1·275	24·858	3·175	3·027	2·863
56	1·280	25·295	3·237	3·090	2·932
57	1·285	25 750	3·308	3·158	2·988
58	1 290	26 210	3·381	3·227	3·053
59	1·295	26 658	3·452	3·364	3·117
60	1·300	27·110	3·524	3·394	3·182
61	1·305	27·611	3·603	3·439	3·253
62	1·310	28·105	3·682	3·514	3·324
63	1·315	28·595	3·760	3·593	3·395
64	1·320	29·161	3·849	3·674	3·475
65	1·325	29·574	3·919	3·742	3·539
66	1·330	30·058	3·997	3·816	3·610
67	1·335	30 535	4·072	3·891	3·681
68	1·340	31·018	4·156	3·967	3·754
69	1·345	31·490	4·232	4·042	3·824
70	1·350	31·948	4·312	4·116	3·894
71	1·355	32·446	4·396	4·196	3·970
72	1·360	32·930	4·478	4·274	4·043
73	1·365	33·415	4·561	4·354	4·109

Degrees Twaddle	Specific Gravity	Per cent by wt. of Caustic Soda.	℔. of actual NaOH contained in 1 gall. commercial caustic soda lye.		
			77°	74°	70°
74	1·370	33·905	4·645	4·434	4·194
75	1·375	34·382	4·728	4·513	4·263
76	1·380	34·885	4·810	4·592	4·344
77	1·385	35·328	4·893	4·670	4·418
78	1·390	35·795	4·975	4·794	4·493
79	1·395	36·258	5·058	4·828	4·567
80	1·400	36·720	5·141	4·907	4·642
81	1·405	37·203	5·227	4·989	4·720
82	1·410	37·674	5·312	5·071	4·797
83	1·415	38·146	5·397	5·135	4·873
84	1·420	38·610	5·482	5·233	4·950
85	1·425	39·071	5·567	5·314	5·027
86	1·430	39·530	5·653	5·396	5·104
87	1·435	39·986	5·738	5·467	5·181
88	1·440	40·435	5·823	5·558	5·258
89	1·445	40·882	5·908	5·640	5·335
90	1·450	41·335	5 923	5·721	5·412
91	1·455	41·875	6·093	5·816	5·502
92	1·460	42·400	6·191	5·909	5·608
93	1·465	42·935	6 290	6·004	5·679
94	1·470	43·467	6·389	6·090	5·769
95	1·475	43·980	6·487	6·193	5·856
96	1·480	44·505	6·586	6·287	5·948
97	1·485	45·013	6·685	6·381	6·035
98	1·490	45·530	6·784	6·476	6·126
99	1·495	46·041	6·884	6·571	6·216
100	1·500	46·545	6·982	6·665	6·303

Explanation of the Table.

An explanation of the table and the manner in which the table may be used by the manufacturers follows :—

(1) The first column indicates the degrees registered by the Twaddle hydrometer when it is immersed in a lye of caustic soda. This may be read along with figures on pages 85 and 86 to get corresponding figures for degrees expressed in Beaume.

(2) The second column shows the specific gravity of the lye corresponding to any degree Twaddle. For example, the figure in the second column against 36°Tw is found to be 1.180; this means that the specific gravity of the lye at 36°Tw is 1.180, or in other words lye of 36°Tw strength is 1.180 times heavier than its own volume of water.

(3) The third column explains the amount of caustic soda present in 100 parts of the lye. For example, the figure in the third column against 36°Tw is 16.139; this means that when the density of a lye corresponds to 36°Tw., 100 parts of it contain 16.139 parts of caustic soda, both by weight.

(4) The fourth column shows the number of lbs. of caustic soda present in 1 gallon of the lye made with caustic soda of 77 degree strength. In the case of the lye at 36°Tw, the corresponding figure in this column indicates that 1 gallon of this lye contains 1.904 lbs. of caustic soda of 77 degrees.

(5) & (6) The fifth and sixth columns signify the same as above for lye made with caustic soda of 74 and 70 degrees, respectively.

The figures in the six columns given in the above table may be thus profitably used in calculating proportion of water and soda in making lyes of any desired strength.

CAUSTIC POTASH LYE.

Caustic potash lye is made exactly in the same way as soda lye.

A table showing the relation between the specific gravities, degrees registered in Twaddle hydrometer and the percentage of caustic potash per gallon follows :—

Table of Strength of Caustic Potash Solution at 60°F.

Specific Gravity	Degrees Twaddle	Per Cent. KOH	lb. of KOH Per gallon
1·060	12	5·59	0·59
1·110	22	11·31	1·25
1·150	30	15·48	1·77
1·190	38	19·29	2·21
1·230	46	23·22	2·84
1·280	56	27·87	3·56
1·330	66	31·32	4·16
1·360	72	35·01	4·76
1·390	78	38·59	5·36
1·420	84	40·97	5·81
1·440	88	43·83	6·31
1·470	94	47·16	6·93
1·520	104	51·09	7·76
1·600	112	55·62	8·89
1·680	136	60·98	10·24
1·780	156	67·65	12·04
1·880	176	75·74	14·23
2·000	200	86·22	17·24

To cite an example, a solution of caustic potash of the strength of 30°Tw. will require, according to the above table 1.77 lbs. of pure caustic soda for each gallon of water. Calculated from percentage basis, the lye will contain 15.48 parts of caustic soda, both by weight.

MAKING SODA ASH SOLUTION.

In making soda ash solution it is found that ten gallons of water dissolve 7.1 lbs. of pure sodium carbonate at 32°F, 12.6 lbs. at 50°F, 16.5 lbs. at 59°F, 21.4 lbs. at 68°F, 38.1 lbs. at 86°F, 59 lbs. at 90.5°F, 46.2 lbs. at 93° to 174°F and 45.1 lbs. at 212°F. The following table shows the specific gravities of soda crystal solutions of different strengths :—

Table of Specific Gravity of Sodium Carbonate Solution at 15°C.

Sp. Gravity.	Degrees Beaume.	Degrees Twaddle.	Per cent by weight.	
			$Na_2 CO_3$	$Na_2 CO_3$, 10 H_2O
1·007	1	1·4	0 67	1·807
1·014	2	2·8	1·33	3·587
1·022	3	4·4	2·09	5·637
1·029	4	5·8	2·76	7 444
1·036	5	7 2	3·43	9 251
1·045	6	9·0	4·29	11·570
1·052	7	10·4	4·94	13·323
1·060	8	12 0	5·71	15·400
1·067	9	13·4	6·37	17·180
1·075	10	15 0	7·12	19 205
1·083	11	16·6	7 88	21·252
1·091	12	18·2	8·62	23·248
1·100	13	20 0	9·43	25 432
1·108	14	21·6	10 19	27·482
1·116	15	23·2	10 95	29·532
1·125	16	25·0	11·81	31·851
1·134	17	26 8	12·61	34 009
1·142	18	28·4	13·16	35·493
1·152	19	30 4	14·24	38·405

MAKING SALT SOLUTION.

Though salt is added in powder to the soap stock for the separation of soap it is sometimes added in solution form. In making salt solution it will be found that a reddish froth is formed on the surface. It should be skimmed off before use.

At 15°C. water dissolves about 26⅓ per cent. of common salt. The following table gives the specific gravity of sodium chloride at 15°C :—

Table of Specific Gravity of Common Salt Solution at 15°C.

Specific Gravity.	Degrees Twaddle	NaCl per cent.
1·00725	1·6	1
1·01450	2·9	2
1·02174	4·3	3
1·02899	5·8	4
1·03624	7·2	5
1·04366	8·7	6
1·05108	10·2	7
1·05851	11·7	8
1·06593	13·2	9
1·07335	14·6	10
1 08097	16·2	11
1·08859	17·7	12
1·09622	19·2	13
1·10384	20·8	14
1·11146	22·3	15
1.11938	23·9	16
1·12730	25·4	17
1·13523	27·0	18
1·14315	28·6	19
1·15107	30·2	20
1·15931	31·8	21
1·16755	33·5	22
1·17580	35·1	23
1·18404	36·8	24
1·19228	38·4	25
1·20098	40·2	26
1·20433	40·8	26·395 Saturated

THE SOAP STOCK.

The lye being prepared of the density desired, the oil and tallow are to be taken in proper proportions to make a balanced soap stock. It is advisable to combine the hard soap producing and soft soap producing elements in proportions such that the colour, appearance and quality of the soap may be pleasant. Incorporation of cheap oils such as *neem*, *karanja*, etc. may be attempted but the percentage of the oil taken should be between certain definite limits. It is usual to use 50 per cent. of tallow and coconut oil to give the required body to the soap, the rest being made up of groundnut, mahua oil, etc.

CRUTCHING.

This consists in stirring the hot soap in the frames by hand crutchers until the temperature is sufficiently lowered and the soap begins to assume a ropiness. The crutching is also necessary when the silicate of soda, colours, perfumes, filling agents, etc., are to be incorporated in the soap. Crutching may also be performed by mechanical agitators but it requires plenty of time. The crutchers differ with the nature of the soap treated. The completion of crutching is indicated by the smoothness and stiffness of the soap when moved with a trowel and a portion taken out at its point and cooled presents a rounded appearance.

LIQUORING OF SOAPS.

This consists in adding various alkaline solutions such as carbonate of soda, silicate of soda and pearl ash. The addition of sodium carbonate gives firmness to the weak-bodied soap and increases its detergent powers. The strength may vary from 25°Tw. upwards. Use of very strong alkali is to be avoided as that will render the product brittle. Too much of the solution is also not to be added as that would lead to efflorescence on the soap. The percentage should not be allowed to rise above 5.

A slight addition of a weak solution of pearl ash 4°-8°Tw. much improves the appearance of the soap.

Before adding sodium silicate it should be noted if the soap is alkaline or not. This can be introduced when the soap is distinctly alkaline. In the absence of it the resulting soap is liable to become like stone with age. If the soap is acidic it is to be reduced first with dilute solution of silicate. If the fatty acid be present to the extent of 3 to 4 per cent. a solution of 6°Tw is suitable while for a solution with 20 p.c. fatty acid a solution of 18°Tw would be necessary. After this silicate of 140° Tw is added to the extent of 10 per cent. of the soap produced.

REMELTING.

Soaps are remelted when scents and other ingredients are to be added during the preparation of toilet soaps. To remelt, the soap is just cut into thin shavings and then heated in a steam-jacketed pan provided with a number of upright steam pipes. This device hastens the melting of soap, for soap being a bad conductor of heat is hard to melt from below. The time for melting is a greatly variable factor—the more the quantity of water present, the quicker it will melt.

NEUTRALISING.

To neutralise the free caustic alkali in soap various ingredients such as sodium bicarbonate, boric acid, coconut oil, stearic acid, etc. should be added. The best method is the addition of an exact quantity of sodium bicarbonate to neutralise the alkali.

FRAMING.

The soap is generally allowed to cool in special frames. The construction of the frames should be such as to conserve the heat as long as it is necessary for the soap. A long, narrow and high frame retains heat too long while in broad and low frames the soap cools down rather quickly. For mottled soaps the frame should be of wood with a well in the middle for the accumulation of the lye.

For framing fill up the frame with the soap and smooth the surface with a trowel leaving in the centre a heap which slopes towards the sides. The next day the top of the soap is straightened with a wooden mallet. This assists consolidation. The frame is left aside from 2 to 3 days for setting. Then unloose the screws, remove the side plates and bring out the block.

SLABBING AND BARRING.

The block is then trimmed and scraped and is then to be slabbed and barred with special machines. Soap bars are ordinarily made 15 inches long but bars have now mostly been antiquated. The bars are generally cut into cakes having weights of 1 ch., 2 ch., 4 ch., etc.

PILING.

The soaps are then to be piled in such a way that the exposed surface is dried to form a new skin and is case-hardened and thus prevents evaporation of water from within.

Piling may be of two kinds—*open piling* and *close piling*. When the soap is piled in a way that the air has free access it is *open piling* and when the soap is put in storage bins the operation is known as *close piling.*

DRYING.

The tallow soaps which are slabbed and barred while still warm are open piled immediately. In the course of a day a skin is formed which prevents the evaporation of water from within. But oil soaps do not develop this skin quickly. These are exposed on racks to a current of hot air in a drying chamber. On case-hardening the bars are better adapted to be stamped. If not properly dried, no gloss can appear on the soap which may partly adhere to the die.

STAMPING.

After being dried the pieces are ready to be stamped. Use decent dies besmeared with a little oil or saline solution to prevent sticking in the die itself. Finally put the soap on the racks and expose to the air for some time.

For toilet soaps with concave faces it is usual to cut them into shapes to be finally given to the soaps. The moulds may be either pin moulds or band or collar moulds. In pin mould its edges meet very exactly the upper part of the die which carries two pins attached to the shoulder and these are received into two holes in the shoulder of the bottom plate. This artifice helps towards getting symmetrical designs on either face. The superfluous soap is forced out as the dies meet.

Band or collar moulds prevent the squeezing out of soaps sideways. The cake is put into the lower part of the mould and the upper plate which fits within the lower one is pressed on the soap block and gives it a well-defined shape.

CHAPTER VI.

WASHING SOAP.

THE starting point in the manufacture of soaps of all kinds is the selection of the soap stock. Tallow and coconut oil can be used alone; mohua oil, groundnut oil, castor oil, etc., are also used sometimes alone but more often than not they are blended with other oils to produce a balanced stock that would be cheap and at the same time yield a good soap.

SOAP STOCKS.

Recipes of a few soap stocks follow :—

1. Tallow 20 seers, mohua oil 10 seers, groundnut oil 10 seers.
2. Coconut oil 1 md., mohua oil 15 to 20 seers.
3. Tallow 20 seers, groundnut oil 15 seers, mohua oil 5 seers.
4. Mohua oil 1½ md., castor oil 10 seers, sesame oil 15 seers.
5. Castor oil 1 md., sesame oil 10 to 20 seers.
6. Mohua oil 1 md., sesame oil 10 to 20 seers.
7. Tallow 2½ mds., cotton seed oil 1¼ mds., rayna oil 35 seers, rosin 8 seers.
8. Tallow 45 seers, groundnut oil 15 seers, cotton seed oil 12 seers, rayna oil 25 seers, rosin 3 seers.
9. Tallow 50 seers, karanja oil 25 seers, groundnut oil 22 seers, rosin 3 seers.
10. Mohua oil 75 seers, coconut oil 10 seers, karanja oil 12 seers, rosin 3 seers.
11. Mohua oil 1 maund and neem oil 1 maund.
12. Tallow 35 seers, groundnut oil 15 seers, mohua oil 15 seers and punnal oil 35 seers.

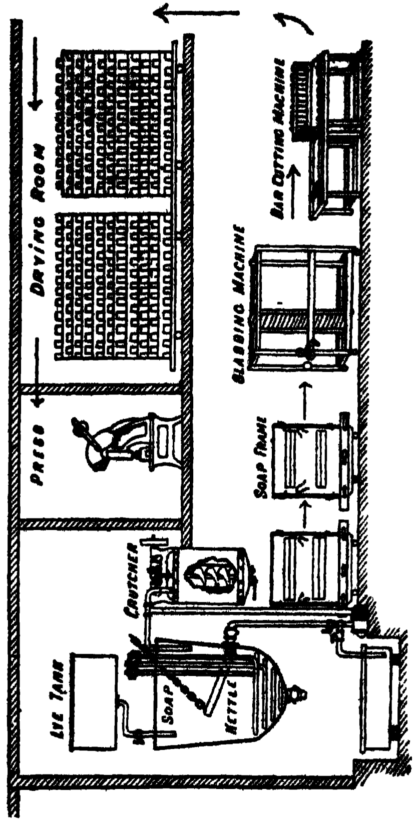

FIG. 16. View of Washing Soap Factory.

13. Tallow 1½ mds., groundnut oil 30 seers, mohua oil 1 md., punnal oil 1¼ mds., and cotton seed oil ½ md.

14. Groundnut oil 1 md., mohua oil 1 md., and punnal oil 1 md.

15. Mohua oil 52 seers, refined punnal oil 45 seers, rosin 3 seers.

16. Tallow 30 seers, mohua oil 30 seers, coconut oil 10 seers, karanja oil 20 seers, sesame oil 7 seers, rosin 3 seers.

17. Tallow 43.5 seers, coconut oil 15 seers, rosin 2 seers, punnal oil 8 seers, groundnut oil 31.5 seers.

18. Tallow 36 seers, coconut oil 15 seers, punnal oil 49 seers.

19. Mohua oil 72.5 seers, coconut oil 15 seers, rosin 4 seers, groundnut oil 8.5 seers.

CAUSTIC SODA.

The quantity of caustic soda for the saponification of any soap stock can be found out from the saponification values already given of various fats and oils. Suppose we take tallow 20 seers, mohua oil 10 seers and groundnut oil 10 seers. Now the mean saponification values of tallow, mohua and groundnut oils are 13.8, 12.4 and 13.5 respectively, which means that

for 100 seers of tallow we require 13.8 seers of pure caustic soda for saponification :

for 100 seers of mohua oil we require 12.4 srs. of pure caustic soda for saponification :

for 100 seers of groundnut oil we require 13.5 srs. of caustic soda for saponification :

Hence for 20 seers of tallow we require $\frac{20 \times 13.8}{100}$ or 2.76 seers of caustic soda; for 10 srs. of mohua oil we would require $\frac{10 \times 12.4}{100}$ or 1.24 seers of caustic soda; for 10 srs. of groundnut oil we would require

$\frac{10 \times 13.5}{100}$ or 1.35 seers of caustic soda. Hence the total quantity of caustic soda required is 2.76 seers + 1.24 seers + 1.35 seers = 5.35 seers.

Usually this quantity is to be added in making soap by the cold process but when soap is made by the boiling process more than this is to be added, say 6½ seers, because some part of the soda is used in bleaching and deodorising the stock as already mentioned. When the oils used are not pure but are much adulterated, the saponification value is to be found out individually according to the process already given on *page* 41.

SOAP BY COLD PROCESS.

(*For general method consult p.* 40 *and* 54).

I.

Coconut oil	2½ mds.
Caustic soda 77°	18 seers.
Water for soda	36½ ,,
Silicate of soda	25 ,,
Water for silicate	25 ,,

Procedure:—In the summer the coconut oil exists in the liquid state and need not be heated at all. When the oil is frozen in winter, it is heated to 80° to 90°F to melt it. Take 18 seers of caustic soda 77° or cent per cent pure. Dissolve in 36½ seers of water. This will make a lye of about 38°Be. Pour the lye into the melted fat or oil in a continuous stream, at the same time stir with a flat wooden stirrer about 3 ins. broad. Continue gentle stirring until the lye and fat are thoroughly combined and appear of the consistence of honey. Do not stir too long, or the mixture will separate again. The time required varies somewhat with the weather and the kind of oil used; from fifteen to twenty minutes is generally sufficient. If silicate of soda is to be added, this may be done at this stage. 25 seers silicate dissolved in 25 seers of hot water may be stirred into. When the mixing is completed, pour off the liquid soap into any sufficiently large frame, previously damping the sides with water to prevent the soap from sticking. Leave it undisturbed until the next day when the box will contain a block of soap, which can afterwards be slabbed and barred.

If the soap turns out streaky or uneven, it has not been thoroughly mixed. If very sharp to the taste, too much soda has been taken; if soft, mild, and greasy, too little. In either case it must be thrown into a pan and brought to a boil with a little more water. In the first case, boiling is all that is necessary; in the other a little more oil or a little more soda must be added.

The finished soap will contain 25 per cent. of water which is a general average. If more water needs be retained in the soap, use weaker lye and vice versa.

If filling agents, colours and perfumes are to be added, this should be mixed before framing by crutching.

II.

Tallow	50	seers
Coconut oil	50	,,
Caustic soda	16	,,
Water	34	,,

Procedure:—Melt the tallow and oil at 100°F. Make a lye by dissolving 16 seers of 77° caustic soda in 34 seers of water. It will be at 70° Tw. Add the lye a little at a time and proceed as in (I).

III.

Tallow	30	seers
Coconut oil	10	,,
Caustic soda lye 36°Be	20	,,
Silicate of soda 40°Be	50	,,
Pearl ash lye 36°Be	8	,,

Procedure:—Put the tallow and oil in an iron vessel and apply gentle heat so that its temperature does not rise above 150°F. When this temperature is reached, transfer the molten mass into frame, pour down the caustic soda lye as quickly as possible and at the same time the fatty matters are continually stirred until the soap begins to thicken up. Now run in silicate and pearl ash with rapid stirring. As soon as any mark made on the surface remains, stop stirring. It should not be disturbed until the soap is cold. It is then cut into bars and stamped.

IV.

Coconut oil	428	parts
Tallow	433	,,
Caustic soda lye (38°Be)	429	,,
Sodium silicate	50	,,
Water for sodium silicate	50	,,

Procedure:—Same as above.

V.

Mohua oil	17	parts.
Coconut oil	3	,,
Soapstone (powdered)	2	,,
Silicate of soda	2	,,
Caustic soda 77°	3	,,
Water	6	,,

Procedure:—Melt and mix the oils together and add slowly to this mixture the caustic soda lye prepared previously by dissolving the caustic soda in 6 parts of water. While adding the lye the oil is constantly stirred until an emulsion is formed. Then add soapstone finely crushed and silicate of soda, and stir again until these are thoroughly incorporated. When the whole mass gets thick, becomes perfectly uniform and translucent and when a sample taken out with the trowel and cooled can be drawn into threads, the soap is run into frames.

VI.

Tallow	34	seers
Coconut oil	6	,,
Rosin	19	,,
Caustic soda lye (33°Be)	32	,,
Sodium carbonate solution (35°Be)	5	,,

Procedure:—The tallow is first melted and ther the coconut oil. Next the rosin is introduced. Wher melted well together, the mixture is allowed to coo down to 130°F, the lye is then added and the soa allowed to stand for about 2 hours. When the soa is finished the sodium carbonate solution is added anc the whole mass crutched well. Now frame and cool.

VII.

Coconut oil	16	lbs.
Castor oil	5	,,
Rosin	10	,,
Caustic soda lye 35° Be	24	,,
Caustic potash lye 30°Be	¾	,,

Procedure:—Melt together coconut oil 16 lbs. castor oil 5 lbs., rosin 10 lbs., and compound the mixture at a temperature of 155°F with 24 lbs. of sod lye of 35°Be. In case a thorough combination is no formed, cover the mixing vessel with cloths and th mixture will in a short time become hot. When thi is the case, stir it thoroughly and when it appears t be intimately combined, stir in ¾ lb. of solution o caustic potash of 30°Be and then pour the paste whic should be uniform and thick, into frames.

VIII.

Coconut oil	1½	mds.
Sesamum oil	1	md.
Caustic soda	17	seers
Water •	34½	,,

Procedure:—Melt the coconut oil, if necessary anc mix with this the sesamum oil. Now prepare a lye b dissolving 17 seers of caustic soda in 34½ seers of water. This will make the solution of a strength of about 38°Be. Heat the oils slightly and pour in the lye gradually with stirring. When the saponification begins, put in frames and allow to cool.

IX.

Coconut oil	2	mds.
Groundnut oil	10	seers
Caustic soda	16½	"
Water for caustic soda	33½	"
Silicate of soda	25	"
Water for silicate	25	"

Procedure:—For adding lium silicate refe *page 54* and proceed as in (I.)

X.

Coconut oil	1	md.
Sesamum oil	30	seers
Caustic soda	12 seers 2	ch.
Water for caustic soda	28	seers
Silicate of soda	15	"
Water for silicate	15	..

Procedure:—Dissolve the caustic soda in water. This will give a strength equal to 36°Be. Then heat the oil as before and add the lye. When the lye and the oil are mixed, add the silicate according to the method given on *page 54*, stir vigorously and frame.

XI.

Coconut oil	70	seers
Groundnut oil	15	"
Caustic soda	15⅛	"
Water for caustic soda	34⅞	"
Silicate of soda	20	"
Water for silicate	20	"
Soap stone	7½	"

Procedure :—Proceed as in (X.) Then mix soap stone in the frame and crutch well.

XII.

Coconut oil	16	seers
Mohua oil	12	„
Castor oil	2½	„
Caustic soda lye 37½°Be	15	„
Water	5	„

Procedure:—Heat the oils in an iron soap vessel to a point when it produces smart cracking sounds when a few drops of water are put in or a little sprinkling of water produces foam. Now mix the lye slowly and stir it thoroughly. Put out the fire. If the oils were properly heated the mixture will boil in a few minutes. When it calms down, add to it 5 seers of water and stir it thoroughly. It will remove all defects from the soap. To impart a pale yellowish tint, like that of sunlight soap incorporate a trace of brown colour into the oil before the addition of the lye.

SOAP BY SEMI-BOILING PROCESS.

(*For general method consult p. 43 and 54*).

I.

Coconut oil	2½	mds.
Caustic soda	20 seers 10	ch.
Water	2	mds.

Procedure:—Prepare the lye which will be at 27°Be. Mix the oil and the lye together, put in an iron pan, and apply heat. Continually stir for 1 or 2 hours, when the paste will gradually thicken. Slow down the heat at this stage but continue stirring. After a time the paste will turn into a white semi-solid mass, which forms the soap. Fill the mass immediately into the frames. Silicate may be introduced as explained on *page 54*.

II.

Tallow	100	lbs.
Caustic soda lye (10°Be)	8	gallons
Caustic soda lye (15°Be)	4	„
Caustic soda lye (20°Be)	6½	„

Procedure:—Melt the tallow with a slow heat. Now add 8 gallons of caustic soda lye at 10°Be and stir well still keeping on gentle fire for 4 or 5 hours. When the fat is emulsified, add gradually 4 gallons of lye at 15°Be. After this the whole contents will form a pasty mass. In order to prevent jamming and break the clothing, add 6¼ gallons of lye at 20°Be. Go on boiling until the whole of the tallow is saponified. Add water to the soap as the lye gets stronger with evaporation of water.

III.

Coconut oil	20	seers
Mohua oil	10	„
Groundnut oil	10	„
Caustic soda	6¼	„
Water	25	„

Procedure:—Proceed as above.

IV.

Mohua oil	1	md.
Wheat flour	1	„
Caustic soda	5½	seers
Water	20	„
Powdered salt	15	„
Soda ash	15	„

Procedure:—Prepare the lye, which should be of about 28°Be strength. Heat the oil in the iron pan. When a cracking sound is perceived on addition of a few drops of water pour down 20 seers of lye. The fire is then withdrawn and when the mass gives out no more vapour pour down sufficient water and again boil for two hours. When the soap thickens remove the fire. Now mix intimately the flour, salt, and soda ash which should be powdered, sift, sprinkle the mixture on the soap mass and stir. Finally add the remaining lye and again stir. Then frame.

V.

Mohua oil	27	seers
Sesamum oil	12	,,
Caustic soda	5¼	,,
Water for caustic soda	25	,,
Silicate of soda	10	,,
Water for silicate	10	,,

Procedure:—Proceed as above. When the saponification is complete, add the hot silicate solution (*p. 54*) to the hot soap stock and mix vigorously. Finally put into frames.

VI.

Coconut oil	1	md.
Groundnut oil	5	seers
Caustic soda	8	,,
Water for caustic soda	1	md.
Silicate of soda	12	seers
Water for silicate	12	,,

Procedure:—As above.

VII.

Coconut oil	16	seers
Sesamum oil	20	,,
Caustic soda	5¾	,,
Water for caustic soda	20	,,
Silicate of soda	5	,,
Water for silicate	5	,,

Procedure:—Same as above.

VIII.

Sesamum oil	20	seers
Groundnut oil	50	,,
Caustic soda	9¾	,,
Water for caustic soda	36	,,
Silicate of soda	10	,,
Water for silicate	10	.

Procedure:—Same as above.

IX.

Mohua oil	1	md.
Groundnut oil	30	seers
Castor oil	15	,,
Sesame oil	15	,,
Caustic soda	14	,,
Water to dissolve	30	,,
Salt	10	,,
Soda ash	10	,,
Wheat Flour	20	,,
Water	1½	md.

Procedure:—The oils are mixed together and heated in a pan till the oils begin to give off vapour. The oils need not be made to boil. Now pour in the lye made by dissolving the caustic soda in water and stop heating. When the soap stock is warm, add water and heat again for half an hour. Stop heating and add powdered salt, soda ash and wheat flour after mixing them intimately and sifting them through a fine sieve. Stir well all the while so that no lumps form in the body of the soap. Finally frame.

X.

Castor oil	1	md.
Sesame oil	4	seers
Caustic lye (38°Be)	14	,,
Water	4	,,
Soda Chloride	1	seer

Procedure:—Mix water and lye, and let the mixture stand for a time. Now place the oils on fire. When the mass becomes homogeneous, add a solution of sodium chloride and again boil. When it has been sufficiently boiled test it by dropping on the ground. If the drop becomes thoroughly dry it is ready for being poured into frame. This is a sufficiently hard specimen of soap. It lathers well and also washes well.

SOAP BY BOILING PROCESS.

(For general method consult p. 44).

I.

Tallow	20 seers
Mohua oil	10 ,,
Groundnut oil	10 ,,
Caustic soda	8 ,,
Salt	5 ,,

Procedure:—The oil is saponified with the caustic soda as shown on *p. 44 & 45*. Now salt out (*p. 46*) with the addition of salt and allow to settle. The salted soap is then taken out or the waste lye is withdrawn. Now melt the soap with the smallest quantity of water to hold it in solution and heat gently. When much froth appears on the soap, frame and allow to cool. Finally trim.

II.

Any soap stock (*p. 98*)	1 md.
Caustic soda	Calculated as shown on *p. 99*.
Filling agents (*p. 29*)	as desired.

Procedure:—Proceed as above and introduce the filling agents before framing and crutch well to have all the ingredients well mixed. For incorporating filling agents *see pages 54* and *94*. The soap, should be distinctly alkaline when silicate of soda is used.

POTMOULDED SOAP.

The following process of making potmoulded soaps and framing and stamping of grained soaps are taken from Bulletins issued by the Industrial Chemist, Department of Industries, Bengal.

Coconut oil	20 seers
Mohua oil	10 ,,
Caustic soda	8 ,,
Salt	5 ,,

Procedure:—The oil is saponified as already noted (p. *44*) and grained or salted out (*p. 46*). The salting process for moulded soap is very exacting. The salted soap should not contain any air bubbles, and the soap is required to be separated in the form of air-free big grains of the size of peas. For this purpose, the soap, as salted before, is boiled gently with the formation of visible convection currents of froth without the appearance of big bubbles. A very low fire is needed for this. As the boiling is continued, the froth decreases and the soap forms into definite grains which gradually increase in size. The process is complete when the soap is free from froth, and it forms into definite grains. This stage is usually attained in about 2 to 3 hours' time. The soap is transferred with a perforated ladle to another pan, kept hot by a jacket in which water is boiled. The object of this is to keep the soap grains hot and plastic till the moulding is complete. During the transference of the soap from the boiling pan, it will be found that some amount of lye is carried over mechanically. In the water-jacketed pan, the soap is rapidly worked by a trowel to break the grains, and quickly moulded into pots, which can be made of any shape to suit the requirements of the trade. The small amount of lye carried mechanically gradually subsides at the bottom and sides, and is occasionally removed by means of a ladle. After the mould is filled with soap the top of it is usually pressed with a coarse cloth to give a smooth surface. The moulded soap in the pots is allowed to stand for a few days to set properly, after which the soap is removed from the mould by a little pressure of the hand applied on one side. The soap may finally be polished with a knife and sent to the market.

In making moulded soap, the worker has to stand by the side of the pan containing the grained soap and bend over its edge to work up the soap with a hand trowel and remove it for moulding in earthenware cups or for cooling frames. It may be seen that for the carrying out of this operation the pan must be of such a size that all the removeable soap can be reached and worked by the worker with his hand. Experience shows that a 38″ deep pan with a proportionate diameter and having a somewhat straight side is about the maximum size that can be used for the above purpose, and as only a few inches of soap are formed in a pan of this size, the output of soap per pan cannot be much. This is a serious draw-back for factories requiring a high output, as they have at present no alternative other than the multiplication of units, which takes up considerable factory space and requires the employment of a large number of operatives. Further, it entails considerable cost on fuel, for the small, direct-fired pans are notorious for their excessive fuel consumption. These factors necessarily increase the cost of production to a great extent. These drawbacks can be rectified by following improved methods detailed on *p. 115.*

GRAINED OR DHOBI SOAP.

In making grained or dhobi soap the saponification is conducted in exactly the same way as in the existing process (*p. 44*). On the completion of saponification common salt is thrown into the pan and the contents thereof are kept at a gentle boil. The soap gradually separates from the lye and takes a granular form. The graining is accompanied by progressive dehydration of the soap, and, in order to be successful, should proceed slowly. The gentle boil should be continued so long as the soap grains do not become too hard to be worked up by the trowel into a soft mass like fluid clay. When this limiting stage is reached the soap is ready to be transferred into the frame. The superficial froth should disappear by this time, but if it does not, the boiling cannot safely be continued on that account. For, on continuing the boiling until the disappearance of the froth in such a case the soap grains may become too hard to impart compactness to the soap in the frame. In cases where the soap is desired to be framed in a highly concentrated form, the operation of dehydration by boiling may be continued for some time more.

On the conclusion of graining, the pan is allowed to rest for some time to allow of the settling of the spent lye. The period of rest varies from twenty minutes to one hour according to the size of the charge. If allowed too long a rest, a portion of the soap solidifies and cannot be worked up into coherent soap for transferring to the frame.

After allowing due rest the superficial froth, if any, is removed from a portion of the pan and the grained soap is worked rapidly by means of a trowel so as to break the soap grains into a viscous clay-like mass, care being taken at the same time not to disturb the lye underneath. The worked up soap is then quickly transferred into the soap frame. It is essential that the grain-breaking and transferring should be done quickly, and for this purpose there should be sufficient number of hands to deal with the soap charge in the pan in a short time. The yield of soap per boil depends on the quantity of soap successfully transferred from the pan into the frame, before the soap congeals. As much soap as possible should, therefore, be taken out of the pan without, of course, allowing it to be contaminated with the lye.

Framing.

To remove a comparatively large portion of the soap without allowing the same to harden up or enclose lye, hollow tins, with weights placed inside, are lowered into the soap in the pan in regions away from the workers until the tins float on the lye. The soap displaced by the tins moves on towards the region of work and increases the thickness of the soap layer there. In this way a very large portion of the soap can be put into the frame directly from the soap pan. Wooden blocks of sufficient weight may also be used to displace the soap for the above purpose.

The frames used need not be very large. These may have a size of say, 17″ high, 24″ long and 12″ wide or even 22″ high, 24″ long and 12″ wide, or any similar dimensions. The top of the soap mass in the frame after filling up should be levelled with the trowel before setting aside to cool.

The cooling and setting of soap in the frame requires from 3 to 4 days depending upon the degree of dehydration of the soap in course of graining, the size of the frame, and finally, the season. The block of soap obtained on removing the sides of the frame is found to be neat and compact and capable of being slabbed, barred and cut into pieces by means of the usual slabbing, barring and piece cutting apparatus. The slow cooling of the soap in the frame usually secures for the soap a fine coherent body which cannot be attained in pot-moulded soap which cools down in a few minutes. If a still better appearance and concentration of the soap is desired the end can be achieved by double salting which improves the body and texture, lessens dullness, and brings about further improvement in the colour of the soap. In the case of double salting however, the first graining should be stopped as soon as the soap clearly separates from the lye.

Stamping.

The pieces cut in the usual way can be stamped after drying in the air for a day or two. If, however, it is desired to stamp the pieces on the same day that they are cut, a superficial drying at 60°C. for half an hour to an hour and a half will help to develop good gloss and correct impression. The stamping is best done, for factories of moderate output, by means of a foot-operated pendulum press. While at work the dies of the stamping press should be sponged or wiped from time to time with the spent lye or a solution of common salt and glycerine in water.

IMPROVED METHOD OF MAKING GRAINED SOAP.

The following method of making grained soap is recommended in Bulletin No. 52 published by Department of Industries, Bengal.

In this process the saponification and the graining are done in the same pan.

The use of a large steam-heated pan in the place of a number of direct-fired pans of a small size is recommended. This results in saving in fuel and labour and ensures a better product, for the considerable darkening of colour of the soap caused by strong and unequal heating in direct-fired pans is altogether got rid of.

The pan is made of sheet iron, the diameter of which is one and a half times the depth. The pan should be slightly rounded at the bottom, the entire bed of which should be covered with the indirect steam coil. At the centre of the bottom there should be a short direct steam coil with perforations on all sides. In this pan both the direct and the indirect steam can be used during the saponification, while during the graining the direct steam alone. It can be made as large as those in use in the biggest soap factories for the making of fitted soap.

The saponification of oils and fats is carried out according to the standard method of soap manufacture. After the graining operation, the soap is transferred over channels assisted by gravity, or pumped into a crutching pan which consists of a deep round-bottomed cylindrical tank of sheet iron, having an outlet at the bottom large enough to empty it quickly and provided with a mechanical stirring or crutching gear. For facility of work the crutching pan shall be placed at some height from the floor so that the crutched soap can be quickly discharged into the frames placed underneath without any intermediate cooling taking place. The size of the crutching pan shall be such as to be able to take the entire charge of grained soap of the original pan.

As the saponification and graining may take more than two days, a single crutching pan will suffice to handle the output of two or more regular saponification and graining pans. After transference, the soap in the crutching pan is allowed to stand, preferably overnight to effect a proper settling of the lye. The separated lye is next drawn off, leaving only the neat soap in the pan. The crutching gear is now put into operation and the soap crutched for 10 to 15 minutes, depending on the character of the soap, until a homogeneous soap mass is obtained. The soap is thereafter run directly into frames placed below the outlet. In the frame a slow rate of cooling is necessary for a further disengagement of the lye before the setting of the soap takes place.

The more thorough the elimination of the lye, the lower the salt content and the better the body of the soap. The frames may be large or small. The large ones may be made of iron as the soap in a large mass takes a long time to cool. The small frames, however, shall be made of wood.

PALE SOAPS.

Bar soaps otherwise known as rosin soaps or pale soaps owe their colour and characteristic odour to the rosin they contain, though a small amount of artificial colouring matter is sometimes added. The best types are made from tallow with an admixture of from 15 to

25 per cent of rosin. A lower grade bar soap, containing 62 to 64 per cent of fatty acids is made from tallow or bone fat, with pressed coconut oil, cotton seed oil or cotton soap and a darker rosin, the unbleached cotton seed oil imparting a brown colour to the soap. The proportion of rosin to be added depends upon the firmness of the other materials employed. If much cotton seed oil is used, it will not be possible to add any considerable quantity of rosin without injuring the body of the resulting soap. In the case of genuine soap, though this defect can be rectified by crutching in sodium carbonate or silicate, it is generally advisable to use firmer stock with less rosin. For a brown soap, a fairly dark coloured rosin may be used.

In cheaper bar soaps the proportion of fatty acids amount to 50 per cent. or even less. These are prepared by 'liquoring' or running soaps as described on *page 94* but more coarsely fitted (*page 49*) by admixing in the crutching pan solutions of sodium carbonate, silicate, chloride or sulphate. The two former have distinct detergent qualities and their addition to soap is often justified on this ground. They also very much reduce the cost of a soap owing to their hardening property, which permits of the use of a large proportion of oil or rosin in the stock or of a greatly increased percentage of water in the finished soap.

Method of Using Rosin.

Rosin is a good cheapening agent for pale soaps owing to its forming a soap having good detergent properties. When using rosin it is a good plan to saponify it separately and then add it to the soap made from the oils. Sometimes soda is employed to convert the rosin to soap, in which case the rosin is melted over water in a steam-jacketed pan, while in another pan ordinary soda crystals are dissolved in a small quantity of water. The proportions are 17.2 lbs. of soda crystals to 112 lbs. of rosin. The soda liquor is added to the rosin in small quantities at a time, waiting until effervescence ceases before adding a succeeding quantity of soda. After all is added, the soap is boiled for a short time to finish the saponification. Then the soap is run into the pan of rosin soap.

The rosin of the usual grades produces darkish-coloured soap. An improvement may, however, be effected by adopting the following method of purification. The rosin is saponified by soda as described above; the rosin soap is salted out by the addition of ordinary salt and time is allowed for the soap to settle. Then the lye is run off, carrying with it a large proportion of the colouring matter of the rosin. The rosin soap thus purified may be added to the soap to which rosin is to be mixed. The soap is finally saponified with caustic soda lye, or, as is more generally adopted, as a rosin charge. The pan is opened with caustic soda lye and saturation of the rosin takes place rapidly; when completely saponified it is grained with salt, and the coloured lye is allowed to deposit and finally withdrawn. Then crutch and put into frames.

Hardening Pale Soap.

Rosin soap is generally of a soft consistency. Hence to compensate it some sodium silicate or soap stone is incorporated in the mass. This hardens the soap and brings it to the proper consistency.

Sometimes, silicate settles below being heavier. Care should be taken to stir the silicate after the whole soap becomes perfectly cool and thick. If treated with silicate, the silicate should be mixed with 10% caustic soda lye extra and added to the soap. Soap stone powder or china-clay may also be added to the soap but in that case, the soap will be heavy and opaque.

I.

Tallow	1	md.
Rosin	24	seers
Caustic soda	9¾	,,
Water	22¼	,,

Procedure:—The tallow is saponified according in the general process of soap boiling and is salted out (*p. 46*). The spent lye is run off. Rosin is now added with fresh alkali and the whole is boiled till the rosin is saponified. This is known as rosin boiling. Now salt out again and allow the dark waste lye to settle for a long time and withdraw it carefully. The soap is then framed, slabbed and barred.

II.

Tallow	1	md.
Rosin	24	seers
Sodium silicate	10	,,
Caustic soda	10¼	,,
Water	23¾	,,

Procedure:—First melt the rosin with all or part of the fat in an iron pan over moderate fire. When the mixture is at 150°F add the lye made with caustic soda and water which should be of 36°Be and stir continuously. Arrange the fire so that the temperature remains steady thereabout. After the mass has been mixed for half an hour, the soap will at first thicken, then grain; and it may again become thick before it becomes smooth. When the mass is perfectly smooth and homogeneous, drop into a frame and crutch in the frame by hand to prevent streaking. After standing for the required length of time the soaps may be moulded or stamped as desired.

III.

Tallow	2½	mds.
Coconut oil	12	seers
Rosin	14	,,

Caustic soda	19 seers
Water	2¼ mds.

Procedure :—Prepare the lye with soda and water. The solution would register 23°Be. Heat the tallow and oil in an iron pan and gradually run in caustic soda lye, till the goods have lost their greasiness and form into scales when pressed between finger and thumb. When this is the condition remove from fire and gradually add salt to grain the goods (p. *46*). Let it rest for three or four hours. Now run off the spent lye through the valve at the bottom of the pan. Next the pan is again heated and the rosin broken up into small lumps is added. Now gradually pour caustic soda till the rosin is saponified. Boil well together for about two hours. Salt out again as before, till the half-spent lye is quite clear, when put aside to cool. Let it rest for 24 hours, when the whole will separate out in four layers, as explained on *p. 49*.

The frothy soap is collected and boiled with the next batch. The niger is also reserved for subsequent treatment. The good soap is taken out and is again boiled with a little caustic soda lye of 28°Tw for about 2 hours, then framed and cut into blocks.

The oils may be saponified together with the rosin but in that case the spent lye after the first salting runs to waste.

IV.

Raw tallow	60 seers
Mohua oil	30 ,,
Punnal oil	10 ,,
Caustic soda lye 36°Be	60 ,,

Procedure:—Put the tallow in a suitable pan and heat so as to melt it. Then remove the fire and slowly add half of the lye with continuous stirring. Then boil until saponified. This boiling goes on for 2 full days in the course of which the other oils are added and more of the caustic soda lye. Sufficiently more caustic soda lye is taken which settles at the bottom when the boiling is finished. Soap is allowed to rest overnight and the upper layer is removed to another pan next morning where it is paddled and dried and cut into bars.

V.

Tallow	50	seers
Groundnut oil	20	„
Rosin	30	„
Caustic soda lye of 36°Be	35	„

Procedure:—Saponify rosin with 10 seers caustic soda and 10 seers extra water. When saponification is complete, add the other oils and the rest of caustic soda and boil after boiling method. When complete saponification is assured the soap is transferred into the crutching pan and mixed with sufficient water, to suitable consistency.

This bar soap may be rendered cheap by the addition of silicate which may be stirred in the boiled soap after the emulsion is complete.

TREATMENT OF SOAP WASTE.

When charges of soap are spoiled on account of an addition of excess of salt or of too little of it or due to defective saponification, etc., the spoiled charges are to be first salted out. These are next dissolved in water, the end of the saponification is tested according to method suggested on *p. 45* and the soap is grained out by the addition of just sufficient amount of salt.

To recover soap from the dirty and waste soap of the factory, the stock is first dissolved in water, and solid impurities are removed by a ladle. The soap is then concentrated and salted, when it separates at the top, leaving all the dirt and lye at the bottom. If the separated soap is not pure enough it is salted again when soap of good quality is obtained. This recovered soap can either be added to new charges of fats and oils to be saponified, or dissolved along with salted soaps to form frame soaps.

TREATMENT OF NIGER.

The niger soap obtained from the settling process is of variable quality according to the quality of the raw materials. If it be white coloured it may be transferred to the boiling pan where more lye is added. After boiling, the soap is salted out as before. The best part of the soap may be moulded and framed and the other portions may be used with the next batch. Niger soaps of dark colour can only be re-used in making brown soaps.

RECTIFYING SOAP BATCH.

When boiling of soap is done imperfectly, there are signs of the soap getting viscous or the lye separating out from the soap which tends to become grainy.

Viscosity of soap is mainly due to the presence of unsaponified fat or rosin in the body of the soap. In such cases addition of a little lye will rectify this defect. In cases where an excessive amount of lye has been added, the soap can be rendered neutral by addition of a quantity of coconut oil.

In cases where lyes separate out it is mostly due to the lye getting extra strong. In such cases either the lye is to be diluted with water or absorbed by incorporation of some substance like flour and starch or neutralised with further addition of oil or some acid.

CHAPTER VII.

TOILET SOAP.

TOILET soaps demand the greatest attention from the manufacturers. Besides possessing delicate colour, they should have compact appearance and delightful scent. The following are the chief characteristics of a good toilet soap:—

(1) The soap should present a glossy compact form and should be free from any cracks which are either due to uneven pressure in the plodder or the presence of too much salt in the soap chips. Its form should not give way to the very last.

(2) The soap should dissolve readily in water yielding profuse white lather. It should not be easily wasted.

(3) The soap should be perfectly neutral as presence of any free alkali will prove irritating to the delicate skin and rob the skin of the natural oil present in it.

(4) There should not be any free oil as this is liable to get rancid in course of time and may even tell upon the odour of the soap.

(5) The colour in the soap should not be present in any quantity to dye the skin or the garment. The froth should be perfectly white.

(6) The soap should retain its perfume right up to the last thin layer in use.

(7) The soap should neither sweat on exposure to air nor dry up.

The starting point in toilet soap manufacture is to make the soap according to the cold or the hot process as already detailed and then to incorporate suitable colours (*p. 35*) and perfumes (*p. 31*) by crutching. Needless to mention that only materials of superior quality should be used to get good soaps.

The toilet soap can ordinarily be made by three processes, viz., by cold process, by remelting, and by milling.

TOILET SOAP BY COLD PROCESS.

When the toilet soap is to be made by the cold process, proceed exactly as shown on *pages 40-43* and *page 100* taking care to use the finest fats and oils. See that the amount of caustic soda added is just sufficient to neutralise the oils and fats. If the soap is alkaline, the perfumes when added may be adversely acted upon by the free alkali and the whole effect may be lost.

When the soap is ready, it is put into a crutcher or mixer (*p. 70*) and a small quantity of coconut oil is added to neutralise any alkali which may be present in the soap. Then colours and perfumes as desired are added and mixed intimately. After some crutching filling agents (*p. 29*) should be stirred in a finely ground state. Finally frame, slab, bar and stamp. For white soaps colours should be left out.

When colours such as cadmium yellow, vermilion ultramarine, umbers, chrome green, chlorophyll, ochres, are added to the soap stock these should be ground finely before use. If coaltar colours are to be added these should be previously dissolved in boiling water or spirit as the case may be. Usually ½ lb. of the mineral colour will be sufficient for colouring 1 cwt. of the soap. But for coal tar colours no definite rule can be given. For 1 cwt. of the soap, use 1 oz. of Fluoresceine Yellow, Soap Yellow or Metanil Yellow, dissolved in 5 oz. boiling water; 1½ oz. of Brilliant Rose or Rhodamine dissolved in ½ pint of water, 2 oz. of Fast Light Green or Brilliant Orange or Methylene Blue dissolved in ½ pint boiling water; 5 oz. Soap

Brown dissolved in 1 pint cooling water. Suitable colours such as Bismarck Brown may also be incorporated.

Perfumes like terpineol, citronella, carraway oil, anise oil, mirbane or artificial oil of almonds, are usually added. Perfuming should be done carefully and should not be too heavy. For white soaps the most useful perfumes are citronella oil, lavender oil or thyme oil while for coloured soaps palmarosa oil, cassia oil, bergamot oil or geranium oil may be employed *(p. 31)*. Perfumes are generally used in the proportion of 1½ to 2 lbs. of essential oils per 100 lbs. of soap.

It is clear that the yield of soap made by this process is the greatest possible since no part of the ingredients is lost during manufacture. The soaps by cold process have a compact mass, and do not crack. The elimination of high temperature renders them highly suitable for the incorporation of perfumes. The soaps can also be produced on a small scale, and can be cut into decent tablets. But the quality is not very high on account of incomplete saponification. Both fat and alkali may however be present in the free state, both of which are injurious.

A few recipes follow :—

Windsor Soap.

White Soap (Tallow and Coconut Oil)	75	lbs.
Citronella Oil	1	lb.

Procedure:—Proceed as above. The soap is then framed, slabbed, barred and punched as usual.

Brown Windsor Soap.

Soap	75	lbs.
Cotton Seed Oil	2	,,
Oil of Mirbane	1	lb.
Bismarck Brown	1	oz.

Procedure:—Proceed as above.

Almond Soap.

Coconut Oil & Tallow Soap	75	seers
Oil of Marbane	¼	seer
Oil of Bergamot	¼	„

Procedure:—Proceed as above.

Rose Soap.

Coconut Oil Soap	75	seers
Oil of Rose Geranium	12½	tollahs
Oil of Bergamot	12½	„
Tincture of Musk	1¼	„
Eosine	2½	„

Procedure:—Proceed as above.

Lemon Soap.

Coconut Oil & Tallow Soap	75	seers
Oil of Lemon	6	ch.
Oil of Bergamot	12½	tollahs
Oil of Lemongrass	15	„
Oil of Cloves	6¼	„

Procedure:—Proceed as above.

Violet Soap.

Coconut Oil & Tallow Soap	42½	seers
Dried Orange Peel	12	ch.
Violet Root	1¼	seer
Tincture of Musk	3¾	tollahs
Oil of Bergamot	2½	„
Oil of Citron	2½	„
Oil of Casein	2¾	„
Oil of Neroli	2	„
Peru Balsam	1¼	tollah
Tolu Balsam	½	„

Procedure:—Proceed as above.

Orange Soap.

Coconut Oil & Tallow Soap	75	lbs
Oil of Orange Peel	6	oz.

Oil of Cinnamon	½	oz.
Oil of Thyme	10	drs.

Procedure:—Proceed as above.

TOILET SOAP BY REMELTING.

When preparing soap by remelting, first a soap of good quality and light colour is selected. The soaps are then cut into thin shavings with chipping machines and are then charged into the remelter. Soaps made both by cold and boiling processes are suitable for the purpose. It is advisable to allow some hot water or steam into the remelter to give the soap the necessary degree of moisture.

The soap when melted is transferred into a crutcher where colours and perfumes are mixed and then the soap is allowed to be run into frames.

Bouquet Soap.

Tallow Soap	20	seers
Coconut Oil Soap	20	,,
Oil of Bergamot	3	oz.
Oil of Rose Geranium	1	,,
Oil of Carraway	¾	,,
Oil of Citronella	¾	,,
Oil of Lavender	1	,,

Santal Soap.

Tallow Soap	25	seers
Santal Oil	1	seer
Bergamot Oil	10	oz.

Heliotrope Soap.

Tallow soap	20	seers
Oil of Almonds	1	oz.
Oil of Neroli	2	,,
Benzoin	3	,,

Almond Soap.

Tallow Soap	75	lbs.
Coconut Oil Soap	25	"
Oil of Bitter Almonds	12	oz.
Oil of Citronella	2	"

Windsor Soap.

Tallow Soap	50	lbs.
Coconut Oil Soap	25	"
Cotton Seed Oil Soap	25	"
Oil of Cinnamon	4	oz.
Oil of Cloves	2	"
Oil of Carraway	1	"
Oil of Sassafras	2	"
Oil of Bergamot	4	"
Bismarck Brown	8	"

MILLED SOAP.

The toilet soaps made by the milling process are far superior to those made by the previous processes. They have a uniformly denser structure, lesser proportion of water and a neat glossy appearance and are not quickly wasted. The process is mainly mechanical requiring the use of additional machines, such as cutting machine, drying machine, crushing machine, squeezing machine, steam stamping machine, etc.

On account of the laborious processes to be undergone it is only the highly-priced varieties that are made by the process. The soap stock should therefore be of the finest quality, free of alkali or any unsaponified fat. No inferior materials should go into the composition of such stocks. Ordinary soaps made of tallow and coconut oil are best suited to be milled and should be properly boiled on strength (*p. 48*), fitted (*p. 49*) and settled (*p. 49*).

General Method.

First cut the soaps into very thin strips. The finer the scrapings, the quicker they will dry. These are then transferred to the drying chamber through which a current of hot air at 60°C may be made to pass (*p. 69*). The soap should neither be too dry, nor too damp. Usually 10 to 15 per cent of moisture in soap is the right degree of dryness to aim at. If a greater proportion of moisture be present the soap will not work smoothly in the subsequent stage while a lesser amount of water will cause the soap to be irregular in texture.

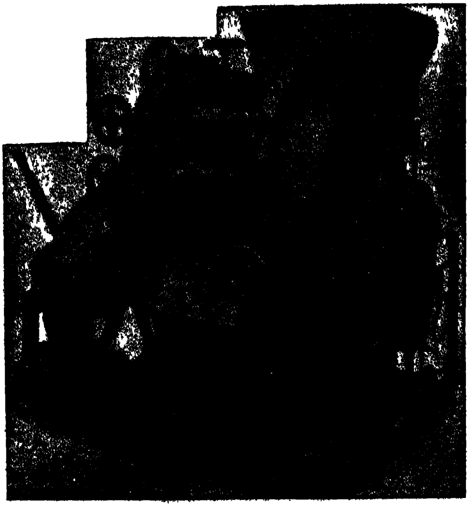

FIG. 17. Multiple Soap Roller.

The perfumes and coal tar colours, if any, are now mixed with the soap which is sent through the crusher (*p. 71*). By the milling operation, repeated thrice or four times a perfect amalgamation is ensured. The pressure between the rollers may be increased by suitable adjustment as the operation nears completion. The mineral colours are best added to the soap stock when in a paste condition. These being fire-proof are not affected by heat.

The crushed stock is next passed through the plodder (*p. 71*) which squeezes the soap and causes it to pass through a narrow mouth. The perfumes may be added at this stage. The pressure under which the soap is expelled makes it glossy. The mouthpiece however tends to get hot and the emerging soap bars

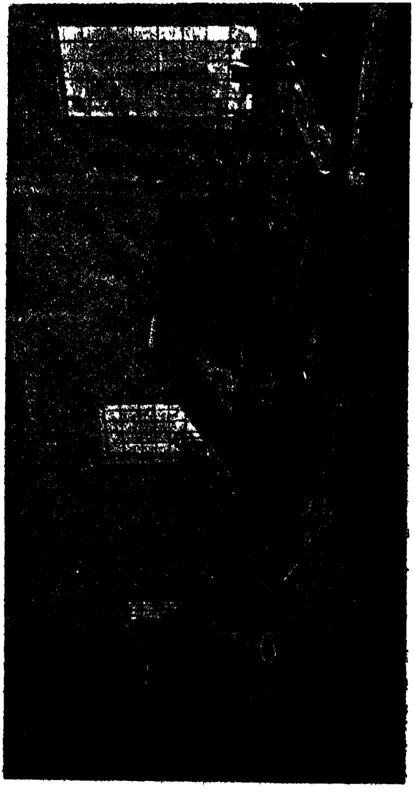

FIG. View of Toilet Soap Factory.

become soft and fail to secure a high polish. In such cases the mouthpiece is to be cooled down by passing cold water round it in a jacket provided for the purpose. The heating of mouthpiece at the extreme end is, however, recommended, for it imparts a high gloss. While working the machine the first batch that emerges, being not fully compressed, is returned to the machine. If not fully compressed the soaps may crack on keeping. If the mass be too dry for working, a little glycerine may be mixed with the soap, to ensure uniformity of texture.

I.

Tallow	10 parts
Coconut oil	1½ ,,
Best refined lard	1 part.
Caustic soda lye 40°Tw	q.s.

Procedure:—Melt tallow and oil, and put the mixture into the soap boiling pan fitted with a stop-cock at the bottom. Heat up. When nearly boiling, add caustic soda lye of 40°Tw and continue boiling for about 2 hours, until all the oil is saponified (which is known to be the case when no oily specks can be observed floating on the surface of this soap). Then salt out by putting salt over the surface of the boiling mass until the soap is found to have separated from the spent lye, and floats freely on the top of the spent lye. Now remove the fire and leave the pan to settle till the following morning. Now run off the spent lye through the stop-cock until the soap commences to flow. The stop-cock is then closed. The spent lye which has been run off contains the separated glycerine, which may be recovered afterwards.

Now, boil up the soap again and gradually run in caustic soda lye of 30°Tw until the residual fatty matter of the previous operation has been completely saponified. The addition of caustic soda lye must be made slowly and very cautiously while a steady boil and close observation are in progress, otherwise the soap will contain traces of free alkali, which is objectionable, as the soap must be perfectly neutral. The batch is again boiled for about three hours and again *salted out* as before with a sufficient quantity of salt. To ascertain whether the salt is added in excess, a metallic rod is plunged into the boiling mass, and is gently drawn. If no soap adheres to the rod, then it must be concluded that the salt has already been added in excess and no more is required. Now the pan is removed from the fire and allowed to rest till the next day, when the half-spent lye is drained off through the valve until the soap commences to flow.

The pan is again heated to boiling and water is added over the surface in a steady constant stream until the soap is quite free from liquor and is closed, and grains and no sponginess can be observed. Afterwards the pan is allowed to rest for a day or two and run into frames. The soap thus prepared is the stock soap for the manufacture of toilet soap. Then proceed as shown on *page 129.* After thorough incorporation the soap is forced through a die plate by heavy pressure forming a long bar which is cut into cakes.. These are then stamped and pressed in the desired shape.

Bouquet Soap.

White soap	100	lbs.
Oil of bergamot	6	oz.
Lavender water	1	,,
Oil of rose geranium	1	,,
Oil of carraway	1	,,
Oil of citronella	1	,,

Santal Soap.

Tallow soap	100	lbs.
Santal oil	5	,,
Oil of bergamot	1½	,,

Citron Soap.

Tallow soap	100	lbs.
Coconut oil soap	25	,,
Oil of bergamot	6	oz.
Oil of lemon	6	,,
Oil of citron	4	,,

Rose Soap.

Tallow soap	75	lbs.
Coconut oil soap	25	,,
Oil of geranium	½	lb.
Oil of rose	2	oz.
Oil of cinnamon	2	,,
Oil of bergamot	1	,,
Oil of cloves	¼	,,
Eosine	1	,,

Millefluer Soap.

Tallow soap	75	lbs.
Coconut oil soap	25	,,
Oil of bergamot	2	oz.
Oil of lavender	1	,,
Oil of cloves	½	,,
Oil of nutmeg	½	,,
Tincture of musk	½	,,

Musk Soap.

White soap	100	lbs.
Powdered orris root	10	,,
Musk	30	grains
Cassia oil	1½	oz.
Lavender oil	1½	,,
Bergamot oil	4½	,,
Citronella oil	1½	,,
Vermilion	3	,,
Soap brown	3	,,

Elder Flower Soap.

Tallow soap	50	lbs.
Coconut oil soap	50	,,

Oil of bergamot	2	lbs.
Oil of lavender	½	lb.
Oil of carraway	½	"
Oil of peppermint	¼	"
Oil of thyme	2	oz.

Lily Soap.

Wax soap	3000	parts
Starch	300	"
Oil of bergamot	16½	parts
Oil of geranium	6½	"
Oil of cassia	1½	"
Oil of sandal wood	⅘	part
Oil of cedar	3⅓	parts
Tincture of musk	3⅓	"
Tincture of tonka bean	3⅓	"
Tincture of storax	10	"

Glycerine Soap.

Nearly all soaps contain a small quantity of glycerine which is not separated in the lyes. In som cases, however, a much larger quantity is desired, u to some 6 or 8 per cent. To mill this great care i required, for the soap tends to blister during compression. The best way is to dry the soap somewha further than is usual, till it contains, say, only 9 or 1 per cent. moisture and then mill in the glycerine. recipe follows :—

Coconut oil	50	lbs.
Caustic soda lye (37.5°Be)	50	"
Glycerine	4	"
Oil of rose geranium	1½	"
Oil of sassafras	¾	"
Oil of thyme	¾	"

CHAPTER VIII.

TRANSPARENT SOAP.

IN making transparent soaps refined tallow, stearic acids and liquid oils are generally used. Castor oil gives the best kind of transparent soap but it makes the soap sticky and the scents fugitive. Coconut oil yields a reliable variety.

When tallow and oils of inferior quality are used, these should be melted on a mild fire and strained through a piece of cloth to remove impurities which would otherwise diminish the transparency of the soap.

One of the most important ingredients which impart transparency to the soap is alcohol. This is a better solvent of soap than water and greatly promotes saponification when it is employed in addition to caustic lye. Hence transparent soaps usually contain alcohol which leaves a transparent mass after evaporation.

Alcohol to be used for the purpose need not be pure rectified spirit. 90 per cent industrial alcohol denatured with 5 per cent wood naphtha will serve the purpose as well.

Glycerine also promotes transparency but when present in excessive quantity it is liable to make the soap rather soft and sticky. Sugar also increases transparency and improves the structure. But being a hygroscopic substance, too much of it makes the soap sweat and slippery.

Transparent soaps are also made by dissolving tallow or soft soaps, rendered perfectly free from water, in warm alcohol. The presence of rosin in the soap favours transparency.

Hence it is common with the manufacturers to use tallow-rosin soap which has been dried and sliced into small pieces.

The soaps are, however, made both by the cold and hot process. During manufacture precautions should be taken to ensure complete saponification.

The principles of manufacture will be evident from the typical recipes that follow. It will be seen that reliance is not placed on any of the ingredients which promote transparency, for as already explained too much of any ingredient has a deteriorating influence on the mass of the soap. It is only when the ingredients are added in proper proportions as not to any way disqualify the soap for the purpose it is meant, that the best results are capable of being achieved.

I.

Soap	50	lbs.
Alcohol	50	,,

Procedure:—Use either tallow or soft soap. Cut into thin slices or shavings which are then dried over a water bath, or by hot air. It is sometimes the practice to powder the soap after drying. The soap and the alcohol are then put into a still, heated by a water bath. Only moderate heat is applied, otherwise the spirit would pass over without dissolving the soap.

If it is desired to colour the soap, any colouring matter soluble in alcohol may be employed, and it is best to colour the spirit before adding it to the soap. To colour the soap red, use aniline colours.

When the soap is completely dissolved, it is allowed to rest for an hour or more, according to quantity, after which the transparent liquid is put into the frames, in which it will solidify on cooling. When cold the soap is cut into pieces of any required size, and these are moulded in the same way as other toilet soaps. The soap does not however, acquire its characteristic transparency until after it has been exposed to dry air for a considerable time.

II.

Soap	100	lbs.
Methylated spirit	36	,,
Crystal sugar	12	,,
Glycerine	12	,,

Procedure:—The soap is first dried and shaved; then it is dissolved in the methylated spirit at a temperature of 130° to 160°F in a still provided with a condenser to recover the alcohol. The solution is then left aside. Salt, carbonate of sodium and sulphate of sodium, if present in the soap, will separate out. The clear portion is drawn off and heated till ¾ths of the alcohol are evaporated. Then frame, colour, perfume and cool. The soap becomes transparent with the evaporation of the rest of the spirit.

III.

Stearic acid	50	lbs.
Coconut oil	110	,,
Castor oil	40	,,
Caustic soda lye (37.5°Be)	100	,,
Methylated spirit	120	,,
Crystal sugar	40	,,
Glycerine	40	,,
Safranine	2½	,,

Procedure:—Melt the first three ingredients and stir in caustic soda. Allow to stand for a few days. Now add spirit to dissolve the soap and heat to 130° to 160°F till a transparent liquid is obtained. Saponification is complete by this time. To recover the alcohol the volatilisation of alcohol may be conducted in stills provided with suitable condensers. Finally add the sugar dissolved in 4 gallons of water and the glycerine. Add the colour and perfumes, if necessary, and crutch well. Put into frames, slab, bar and cut.

Place for some time in a cool dark room. The alcohol then evaporates gradually and the soap hardens and becomes perfectly transparent.

IV.

Tallow or stearic acid	60	seers
Coconut oil	50	,,
Castor oil	40	,,
Caustic soda lye (37.5°Be)	75	,,
Methylated spirit	50	,,
Crystal sugar	20	,,
Water	20	,,

Procedure:—The fats and oils are melted at a gentle heat. Add the caustic soda lye and stir well to ensure thorough admixture. The saponification will be finished in 3 to 4 hours. Then add the alcohol and other ingredients including any suitable colouring matter and perfume and finish as usual.

V.

Tallow	48	seers
Coconut oil	40	,,
Castor oil	60	,,
Caustic soda lye (37.5°Be)	74	,,
Crystal sugar	36	,,
Water	36	,,
Glycerine	6	,,
Soda crystals	10	,,

Procedure:—Melt the fats and oils and stir in the lye, set aside for 24 hours, then boil for 3 to 4 hours to complete the saponification. The soap is then allowed to cool to 170°F. It has then a jelly-like appearance. Now add with brisk agitation glycerine and crystal sugar, then soda crystals, colour and perfume and finish as usual.

VI.

Tallow	54	lbs.
Coconut oil	44	,,

Castor oil	54	lbs.
Caustic soda lye (37.5°Be)	84	„
Crystal sugar	48	„
Water	26	„

Procedure:—As in (III).

GLYCERINE SOAP.

Glycerine soaps are hard transparent soaps made from a neutral settled soap stock. These soaps are generally made of tallow and coconut oil and contain a small proportion of rosin and about 20 to 30 per cent of pure glycerine.

The soaps are generally coloured decently to captivate public attention. To colour reddish brown use is made of leather brown (commercial brand); for violet use methyl violet with English brown; for yellow, use uranium yellow; for red, use scarlet red. These are to be dissolved in the least amount of denatured alcohol or boiling water.

I.

Tallow	30	lbs.
Coconut oil	50	„
Castor oil	30	„
Caustic soda lye 38°Be	55	„
Glycerine	12½	„
Syrup	12½	„
Alcohol 90 %	50	„
Colour to choice	q. s.	
Musk	1	dr.
Bergamot oil	3	oz.
Lavender oil	5	„
Cananga oil	8	„

Procedure:—Melt tallow and oils in a clean soap kettle. Pour in the caustic lye, preferably strained through a cloth and stir till the mass thickens. Keep aside for half an hour and then boil the soap mass on a water bath stirring continuously. When saponification is almost complete, add the freshly prepared syrup. Boil for about an hour more and add alcohol after reducing the temperature of the furnace (*p.* 58). The soap dissolves in the alcohol and into this colours may be added. Now cover the pan and boil at a mild heat. When soap is ready, take the pan away from fire and add the scents. Keep aside and run into moulds prepared of galvanized tin sheet (24″ gauge) in the shape of pipe having the diameter of the soap required. The end of the mould is provided with a removeable cover which is luted with a paste made of earth and flour. When cold, the soap sets and can be drawn out unbroken by slightly heating the mould and pushing with a stick having at its end a piece of board exactly fitting the cross section of the mould. Cut the soap-bars into suitable pieces, and expose them to the air to dry, polish with a cloth moistened with alcohol and stamp as desired. Before packing polish again with moistened cloth as before.

II.

Tallow rosin soap	20	lbs.
Alcohol (90 per cent.)	8	pint.
Glycerine	5	lbs.
Leather brown	10	gr.
Alcohol or Water to dissolve Colour	6	oz.
Geranium oil	½	,,
Cassia oil	1	,,
Lavender oil	2	,,
Sandal oil	½	,,

Procedure:—Dissolve soap in alcohol in a covered pan on water bath. Add glycerine and colour previously dissolved in boiling water or alcohol. Distil off the alcohol and collect it for future use, if possible, in a reflux condenser. Then crutch in the perfumes and mould as in the previous recipe. Soap cutting may be remelted and remoulded as stated. Cuttings may also be used in the soap stock before crutching and moulding.

III.

Fresh tallow 20 lbs. and best coconut oil 10 lbs. are heated in a soap kettle at 170°F. On the other hand 15 lbs. of solution of caustic soda 40°Be, 12 lbs. of 96 p.c. alcohol, 15 lbs. of glycerine, 6 lbs. of brown sugar are mixed together with 2 lbs. of water and likewise heated to 170°F and the mixture gradually mixed with the former under brisk stirring. Saponification takes place in this manner without the necessity of boiling. The reaction is accompanied by a considerable increase in bulk. It may be now covered and after it has cooled a little it may be scented. Finally it is poured into moulds as explained in (1) and then cut into size and stamped.

IV.

Melt refined tallow 10 seers, castor oil 5 seers and coconut oil 10 seers in a clean pan and pour in 12½ seers of caustic soda lye 37°Be. Stir and keep aside till saponification begins which is indicated by rise of temperature. Now boil on water-bath with occasional stirring for about 30 minutes and add 12 pints of alcohol 95 %. Cover up the pan well and continue boiling till saponification is almost complete. Now pour in syrup made up of 10 seers of sugar in 10 seers of water and boil at mild heat, the pan being still covered. Crutch in colours, say uranium yellow 2½ dr. dissolved in 20 oz. of boiling water. When soap is saponified, mix suitable perfumes and set aside for some time. Then scoop off the frothy substance on the top and run the liquid soap into moulds as before and stamp as desired.

CHAPTER IX.

SOAP POWDER

OF late the use of soap powders as a general cleansing agent has become popular. They are employed for scouring purposes in the household. They may be manufactured at a low cost, still retaining their detergent properties. Being a readily saleable article they prove more lucrative than ordinary soap.

MANUFACTURE OF SOAP-POWDER.

Soap powder is simply soda ash and soap intimately mixed, cooled, and ground to a powder. Sodium silicate is also used as an ingredient. In preparing the soap a little more water should be added than is used in finishing settled soap. Should the soap be finished too coarse, the mixture of soap and soda-ash in the crutcher may be too thick for easy working.

MIXING AND FRAMING.

For this purpose the soap-crutcher may be used, but it is desirable that for making the thick, heavy mass of soap and ash the mixer be more strongly built than the ordinary soap crutcher and preferably of the type with either horizontal or vertical blade agitator. The ingredients added to the mixer comprise thin soap, soda-ash, and silicate of soda. These may be in various proportions according to the quality of powder desired. For a single frame 600 to 700 pounds each of soap and soda ash may be used to which 100 to 125 pounds of silicate are added. Soap is run in first, the amount being determined by the level in the mixer and then the ash in successive amounts until the entire weight is added. Addition of entire amount of ash at once may block the crutcher and bend or break the blades of the mixer. The amount of silicate added will depend upon the consistency of the mixture of soap and ash. If the soap is finished too thin, the weight of ash may not be sufficient to counteract the thinness of the resulting mixture, in which event either more ash or less silicate may be added. With soap fitted coarse in the kettle it may be necessary to add water in the crutcher. When a homogeneous mixture has been obtained the mass is framed. One day as a rule suffices for cooling, at the end of which time the mass is stripped and cut. Corners and ends of the frame are usually hard to penetrate which the ordinary soap-slabber is unsatisfactory. Recourse is to be had to hand-slabbing. Should the mass become too hard to be cut by wire, it must be disintegrated by more laborious means. After slabbing it is cut transversely, and the slabs piled up to dry. The frame method is the most cleanly and convenient. According to the floor method, the mixed soap and soda-ash are run directly from the crutcher, used exclusively for this purpose, on to the floor of the apartment, where it is allowed to solidify. After this it is broken into coarse lumps to facilitate cooling and drying. The mass is then further disintegrated, and ground as required. The slabs after disintegration, either by hand or disintegrator, are ready for grinding.

GRINDING SOAP POWDER.

Mills of various types are used for reducing the coarse lumps or slabs to powder. A satisfactory method of handling soap-powder consists in storing the material in a hopper or bin, as it comes from the crusher, and transferring it thence by gravity to the mill as required. In the mill the material is reduced to powder by repeated blows of rapidly revolving steel beaters running in a special casing. The powder is rapidly reduced by the action of the beaters, and the fine materials are instantly discharged through the screen. All parts of the casing are easily accessible for examination and cleaning. The only wearing parts are the screens, which are durable and inexpensive.

Packing Powder.

The usual method is to determine the bulk that the desired weight of material will fill and make the cartons of the proper size to hold this bulk. In this connection it should be borne in mind that there is a difference in the volume that a given weight of powder will occupy, depending on the fineness of grinding. Therefore it is best to use powder just as it comes from the mill to determine this volume before ordering the cartons.

A few typical recipes are given :—

I.

Settled Soap	2½	lbs.
Soda ash 58°	4	,,
Silica	22	,,
Salt	1	,,

Procedure :—The ingredients are mixed in a specially adapted mixer for heavy material until dry. Then run directly to the crusher and pulveriser. After this it is packed, sealed and boxed.

II.

Settled soap	2	lbs.
Soda ash 58°	3	,,

Procedure:—As in (I).

III.

Settled soap	1	lb.
Soda ash 58°	4	lbs.

Procedure :—As in (1).

IV.

Yellow soap	6	parts
Soda crystals	3	,,

Pearl ash	1½ parts
Sulphate of soda	1½ "
Cotton seed oil	1 part

Procedure:—These ingredients are mixed as finely as possible without the addition of any water. The mass is then spread out to dry and then ground into a coarse powder. Thus in an infinite degree can the variety of soap powders be multiplied. This soap is adapted to hard waters, as the excess of alkali neutralises the lime.

V.

Hard soap	5 parts
Soda ash	3 "
Silicate of soda	2 "
Borax	1 part

Procedure:—Each ingredient is thoroughly dried and mixed intimately.

VI.

Soap	85 lbs.
Filler	40 "
Sal soda solution 20°Be	17 "

Procedure:—The dried soap chips are mixed with the filler and alkali and then pulverised.

VII.

Washing Soap	3½ parts
Soda Crystals	12 "
Pure alkali	3 "
Sodium bicarbonate	1½ "

Procedure:—The washing soap should be previously dried and cut up fine. Put down 12 parts of soda crystals and spread out on the floor; on the top of this spread the best washing soap. On the top of this spread 3 parts of pure alkali and 12 parts of bicarbonate of soda. Put this through the edgestones to have the ingredients crushed and mixed well and let stand all night before putting through the disintegrator which powders the mass finely.

VIII.

Soap	8	cwt.
Pure alkali	15	„
Water	16	„

Procedure:—Place in the tank 16 cwt. of water, heat with live steam to 180°F. Cut up 8 cwt. of soap into small pieces, throw it in the tank with the stirrers going at slow speed. Pass on steam until the soap has quite dissolved, then turn off, letting the mass agitate for an hour. Now add gradually 15 cwt. of pure alkali, 58 %, and let the stirrers continue until the whole is well mixed in. The valve at bottom of tank can now be opened and the contents of the tank run to a cooling tank where it is kept aside for at least 18 hours so that the soap formed is hard enough to be ground. The material when dry is dug out of the vats and passed through set of edge-runners to break the lumps, and is then passed through disintegrator, which will reduce it to a very fine powder.

SHAVING POWDER.

Coconut oil	113	lbs.
Caustic soda lye 35°Be	140	„
Caustic potash lye 50° Be	170	„
Stearic Acid	550	„

Procedure:—The coconut oil is heated and mixed with melted stearic acid in a kettle and then the whole mass is saponified with the lyes in the usual way.

The soap is dried in a dryer by keeping the temperature low. It is advisable however during the pulverising operation to add 25 to 50 per cent. dry-tallow soap chips, and about 5 per cent. talc.

CHAPTER X.

LIQUID SOAPS.

THE chief ingredient in the manufacture of liquid soaps is coconut oil. But the liquid soap obtained therefrom causes chaffing of hands in cold weather. Hence in the best varieties of liquid soaps olive oil, palm oil, soyabean oils, etc. are used in combination with coconut oil where available.

A great advantage of using coconut oil in the manufacture of liquid soaps is that the solution is relatively thin as compared to palm oil soaps and thus flow is easier without clogging.

As a general rule caustic potash is used in manufacturing liquid soap. Caustic soda is however mixed to some extent with caustic potash in making cheap qualities of liquid soaps such as those meant for scrubbing the floors, decks, etc.

The manufacture is carried on in a tank or small kettle equipped with an agitator and closed steam coil. A crutcher is also necessary for this purpose. The oil is saponified with caustic potash of 28°Be so that the finished product in the kettle will have approximately 35 per cent. anhydrous soap content. Occasionally the soap is manufactured at a higher concentration and is reduced later with water to the desired strength. The usual proportions are:—Coconut oil 130 parts, caustic potash lye 28°Be 135 parts, water 150 parts.

In actual practice the oil is heated to 125°F and the potash lye is run in. Saponification proceeds rapidly. Cold water is added from time to time to hold this swelling in check. After saponification is completed, soap should be tested and adjusted with oil or potash. The finished product should be alkaline to the extent of 0.5 per cent free alkali. To the finished soap water is added to bring it down to the concentration desired.

Liquid soaps are sold in concentration from 10 per cent to 40 per cent. The most common concentration is 20 per cent anhydrous soap.

I.

Coconut oil	130	seers
Caustic potash lye 28°Be	135	
Sugar	72	
Borax	2	
Water	267	

Procedure:—The oil is run into a jacketed kettle and heated to about 120°F. The potash lye is then added to the oil. Saponification takes place, the mass swells rapidly and may foam over the sides unless a kettle of about four to five times the capacity of the total charge of soap is used. When the saponification has occurred, the sugar, borax and glycerine are added, the water is run in and the mixture stirred until the soap is thoroughly dissolved. Heat helps materially in dissolving the soap. The soap is then allowed to cool and filter. If colour or perfume is to be added, this is stirred in now.

II.

Cotton seed oil	9	parts
Caustic soda	8	
Caustic potash	8	
Alcohol	35	
Distilled water sufficient to make	500	

Procedure:—In a suitable container, dissolve the caustic soda and caustic potash in 50 parts of distilled water, add the alcohol and then add the cotton seed oil in 3 or 4 portions, shaking vigorously after each addition. Continue to agitate the mixture occasionally until saponification has been completed. Then add the remaining portion of water and mix. The only precautions that are at all necessary are to use a good grade of ingredients, and to be sure that saponification is complete before adding the remaining portions of the distilled water. The water used must be absolutely free from soluble salts and for this reason it is preferable to use only freshly distilled water.

Liquid Toilet Soap.

Lard, best quality	30	parts
Sesame oil	6	„
Caustic soda lye (40°Be)	3	„
Caustic potash lye (40°Be)	14	„

Procedure:—30 parts of lard and 6 parts of sesame oil are heated on a water bath to 38°C, the mass being kept as near this temperature as possible; during the subsequent operations first 3 parts of caustic soda lye of 40°Be, previously mixed with one part of water (4 parts), are stirred in a thin stream and then 14 parts of 40°Be caustic potash lye are crutched in similarly. The soap mass is now stirred uninterruptedly, still at the above temperature, until it becomes so thick that stirring is no more possible; this frequently takes some hours, when complete saponification of the fat takes place.

The perfume is ground up in the cold soap-cream, sometimes with the addition of 2 per cent of vaseline.

Liquid Glycerine Soap.

Melt together 274 lbs. pale oleic acid, and 66 lbs. coconut oil, then add 228 lbs. caustic potash lye, 60°Tw, boil up and when saponified add 20 lbs. glycerine and enough methylated spirit to make the liquid clear. The glycerine should be free from lime.

II.

Take 10 seers of soft soap, i.e., soap made with caustic potash. The soap should be salted out with potassium chloride to render it perfectly free from alkali. Melt it and incorporate into it 20 seers of glycerine which should be free from lime. The liquid soap thus prepared may be scented with rose oil and orange blossom oil in equal proportions, the actual amount used being varied according to taste.

III.

Coconut oil	100	lbs.
Caustic Potash lye 28°Be	102	
Glycerine	100	
Sugar	70	
Water	833	

Procedure:—The oil is first run into a jacketed kettle with a stirring device, and heated to about 120°F. The potash lye is then added and the oil saponified. When the saponification is complete the sugar, borax and glycerine are added, the water run in and the mixture stirred until the soap is thoroughly dissolved. The soap is then allowed to cool and if colour or perfume is to be added this is stirred in, after which the soap is cooled and filtered or else run directly into barrels.

CHAPTER XI.

FLOATING SOAPS.

THESE are soaps that swim in water by reason of the air enclosed in them. They are therefore used for bathing purposes. They are made by aerating the soap so that its volume is increased or by incorporating a filler of low specific gravity into the soap.

Floating soaps are also made by incorporating materials of low density with ordinary soap. The substances generally used for the purpose are paraffin wax, wool fat and various other waxes. The amount of wax to be added is readily determined from the densities of the wax and the soap. It must, however, be borne in mind that the wax remains unchanged and thus the lathering property of wax-stuffed soaps gets diminished.

Floating soaps are generally made from tallow and coconut oil of which the latter makes up about 25 per cent. The fat and the oil are saponified separately using an excess of lye which is finally removed by graining out with brine solution.

For aeration of the soap an Archimedan screw operating in the reverse direction is usually employed. This drives the air into the soap. Another method is to use a crutcher fitted with a series of paddles working in the opposite directions on horizontal shafts. The paddles are only partially immersed so that maximum agitation is produced. As the work progresses the soap is tested periodically and floating properties examined. An experienced workman is able to judge when aeration is complete by watching the soap at the edges of the crutcher, and its tendency to solidify there.

Floating soaps can also be readily made from cuttings, the best type of cutting for this purpose being tallow soaps containing 25 to 30 per cent. of coconut oil.

Framing.

The soap should not be run into the frames at too high a temperature, as it will then be too fluid to retain its air content, which will partially escape, with the result that the soap at the bottom of the frame will be denser than that at the top. It should be cooled quickly, as it tends to sink in the middle while it is in a liquid state in the frames, leaving a high proportion of scrap round the edges, which needs to be worked up again. For this reason the soap is often pressed into the soft soap below, but in spite of this the proportion of scrap in all floating soaps is rather high, and is sometimes as much as one-third of the total output.

In drying, the soap should be allowed to stand in the frames for as long as is practicable. It is dried in a cool room, as it tends to crack when exposed to any degree of heat. The block is cut into bars, which are again dried in a well-ventilated room before being finally cut and pressed into shapes.

I.

100 parts of cuttings of tallow and coconut soaps which should be white or at least light in colour are placed in a jacketed pan, and 15 parts of potassium chloride solution of not more than about 20°Be added together with from 60 to 80 parts of water, depending on the state of dryness of the cuttings. Steam is admitted and the cuttings dissolved up. The difficulty of dissolving very old or dry cuttings may be overcome by the addition of 1½ to 2 parts of salt to the pan, sprinkling it gradually on to the surface of the melt, and stirring thoroughly under a good heat. Too much salt should be avoided as this will affect the smooth

surface of the finished tablet. When the soap has completely dissolved it is run into the stirring kettle through a fine sieve which will remove any impurities and the process of agitation and framing proceeded with as usual.

II.

Tallow	135	seers
Coconut oil	15	,,
Caustic soda (9° to 12°)	16	gallons
Caustic potash (9° to 12°Be)	5	
Salt	16	

Procedure:—Saponify 135 seers of tallow and 15 seers of coconut oil in the ordinary way in a large soap kettle with soda and potash lye of 9° to 12°Be, until a clear dark paste is obtained with a slightly alkaline touch. In order to make the stock soap of a good quality, boil the soap after it is fitted for two hours more on a gentle fire. After all the fat is saponified salt out the soap with 7 to 8 per cent of salt so that some lye separates out. Now increase the fire ; add more salt solution of 3° to 4°Be, continue boiling until the soap froths up well for 1 hour. The mass now boils quite light and flaky. If the mass is too strongly salted out, water is added until the lye begins to form a paste. Then withdraw the fire and allow to stand quietly for a quarter of an hour. The sub-lye will separate out and the soap can then be put into frames, not very water-tight, so that lye may escape. Scoop out the soap from the top of the kettle only and fill halfway two low frames of 10 to 12 mds. capacity. Cover them up to retard solidifying. Now work up the remainder of the soap in the kettle to a froth by means of paddles or stirrers and allow to stand 2 to 3 minutes. Divide the mass into 2 portions and pour into the frames. Crutch the contents of the frames quickly into the curd, until the whole becomes uniform. Repeat this operation for 2 or 3 times until the mass becomes quite porous and flaky. Cover up the soap with a lid fitting into the frame and weight with 25 to 40 seers so that it lies directly on the soap. The framing and crutching of the frothy soap must be done quickly, as the soap is liable to solidify soon.

If the soap is to be coloured red or rose the colouring matter (generally alkanet root) is dissolved in the hot fat to give it the required shade. The perfume, however, is added to the soap in the frame before completing the crutching. As alkanet root, with an excess of alkali, easily acquires a violet hue it is best to use red lye-proof colour soluble in water.

After two days the soap can be cut up into blocks and bars. It is advisable to leave the bars exposed to the air for one day to dry.

The cuttings are kept until the next boiling and added when the soap is salted out.

III.

Coconut oil	10	seers
Caustic soda lye 38°Be	5¼	„
Caustic potash lye 25°Be	¼	seer
Potassium chloride solution (20°Be)	2½	seers

Procedure:—Melt the oil and filter. Heat to 90°—100°F and add the alkali with stirring. When combination is complete, cover up the pan. Now add 2½ seers of potassium chloride solution of 20°Be and 10 to 12½ seers of hot water and stir till a uniform mass is obtained. Allow to cool to 77°F. Now beat a small portion of soap with paddles or air brushes. When the mass is frothy, add the rest and stir. Finally frame, crutch, cool and stamp.

IV.

Coconut oil	50	lbs.
Tallow	25	„
Caustic soda lye (36°Be)	40	„

Potassium carbonate solution (20°Be)	40	lbs.
Potassium chloride solution (20°Be)	20	,,
Brine (20°Be)	25	,,

Procedure:—Proceed as usual with coconut oil, tallow and caustic soda. When the saponification is attained, the pan is covered up. Then the potassium carbonate, potassium chloride and brine are poured in gradually with double their weight of hot water. When cool beat the soap to enclose air and become frothy. Finally frame, crutch, cool and stamp.

V.

Good oil soap	27	seers
Water	2½	,,

Procedure:—Make the soap into shavings. Melt the shavings by the heat of steam, or water-bath in a pan furnished with an agitator, which must be assiduously worked till the soap has at least doubled its volume. Next put into frames, cool, and cut into pieces. The soap lathers well and is very pleasant. Any scent may be added during framing.

CHAPTER XII.

MOTTLED SOAPS.

GENUINE mottled soaps are generally prepared from low grade tallow, bone grease, or kitchen grease, with a cheap quality caustic soda. The impurities from the raw materials produce the mottling (*p.* 6).

The mottled soaps as a general rule are made by the boiling process, being pasted, grained and then boiled with strong lye; when the saponification is found to be complete, the boiling is continued until the soap is just sufficiently open to mottle properly on cooling, this being a point which can only be determined by practical experience. In order to determine whether the soap is in proper condition, take a sample on a good-sized wooden paddle. This paddle should remain liquid on the inside for 5 minutes. When the sample is coated, the mottle of the soap should show, otherwise it will not mottle in the frame. When the right condition is reached, the soap is allowed to rest for an hour or two and then quickly run into wooden frames. This mixes the bottom soap at the bottom of the pan with that at the top and renders the mass homogeneous. For good results the frames should be covered with blanket in order to ensure slow cooling.

Mottling effect is however, often made by artificial means. Generally copperas, ultramarine, or manganese dioxide are used to produce the mottle according to the colour of the mottle required. The ultramarine will produce a blue mottle while manganese dioxide, vermillion and copperas will yield grey, red and green mottles respectively.

TWO KINDS.

There are two kinds of mottled soaps known. One has a faint grey mottle scattered through its substance while the other has a prominent mottle or grain of a blue, red, or other colour. We will deal with former type first.

The fats and alkalies used in this preparation are generally contaminated with earthy matters and metallic impurities, these acting upon the fats formed by the alkali.

To produce mottled soap with a good grain requires some experience in soap-boiling. The method usually followed is to make a soap from tallow or bleached palm oil, using low grades of caustic and adding it in large excess. The soap is well boiled, and then it is boiled down with some lye until it begins to curd out; it is at once run into the frames, and these are covered over with cloths to keep in the heat. During the cooling the metallic soaps tend to aggregate together and so produce the mottle. One of the chief arts in making a mottled soap lies in the boiling; if boiled too long it sets too quickly and there is no time for the mottling to form properly, while if not boiled long enough, it is apt to contain an excess of lye, and the mottling settles out too quickly.

Properly filled mottled soap should test around 45 per cent. total fatty acids and 44 or 45 per cent. of moisture.

One most frequently resorted method is to use two crutchers. One crutcher contains a full boiled settled soap, fresh from the kettle and the other contains the same soap to which the required amount of blue or red colour has been added. A trough from the outlet of the first crutcher empties into the frame. The second crutcher containing the blue soap also has a trough which discharges directly into the first trough close to the outlet of the first crutcher. Thus the soap from the first crutcher is mixed with the blue or red soap from the second crutcher as they flow into the frame. They are further mixed with a short-handled wide pronged rake.

BLUE MOTTLED SOAP.

At first soap is prepared from tallow and palm-kernel oil or coconut oil with considerable excess of caustic soda lye. The soap is afterwards removed to a second pan and for every 1,000 lbs. soap are added 250 lbs. of silicate of soda solution, the whole being thoroughly incorporated by boiling until the proper condition of mottling has been reached. This can be determined only by experience, the colouring matter, ultramarine blue, worked up into a thin paste with water, is then slowly sprinkled over the surface of the boiling soap until the full quantity has been introduced; the amount of ultramarine blue to the portion of soap varies from 5 to 10 lbs. If the soap is in too liquid a state the colouring matter is apt to permeate the entire mass giving it blue tint throughout, and the desired mottled appearance will not be attained. When properly conducted the blue pigment shows in the soap in blue patches, which appear in strong contrast to the white ground of the soap, giving it a pleasing appearance to the eye.

I.

Coconut oil	10	seer
Cotton seed oil or low grade tallow	15	,,
Caustic soda lye 40°Be	12½	,,
Silicate of soda	1¼	,,
Water	1	seer
Soda ash	1	,,
Ultramarine	q.s.	

Procedure:—Boil the oils with caustic lye. When the saponification has been completed add liquoring materials consisting largely of silicate of soda solution, together with soda ash and brine. The soap should be distinctly alkaline (*p.* 94). The mixture is thoroughly boiled until a sample withdrawn and tested is found to be in a suitable condition for adding the colouring matter. Add ultramarine in the proportion of 3 to 3½ lbs. per ton. This may be either suspended in a small quantity of water or mixed up with a little of the soap, and sprinkled over the contents of the pan. The soap is then further boiled up until the colour is thoroughly distributed when it is run into wooden frames, and the frames are left undisturbed to allow the soap to cool slowly.

The ultramarine is often worked up into a thinnish paste with water and is then sprinkled over the surface of the boiling soap a little at a time until the full quantity is added.

GREY MOTTLE.

Procedure:—Proceed in the same way and colour with powdered oxide of manganese, from 1 to 3 lbs. to the ton, introduced in the same way as above.

RED MOTTLE.

Procedure :—Same as above ; only colour with vermilion.

CHAPTER XIII.

SOFT SOAPS.

SOFT soap is an amber-coloured to reddish brown material of the consistency of butter. These are more soluble in water than ordinary soaps and possess greater scouring properties (*p.* 3). Light coloured soaps are preferred. The alkali used in their manufacture is caustic potash.

Soft soap, as its name implies, is to remain always in the soft state. It is a semi-boiled soap finished with saponification, and normally contains 40-44 per cent. fatty acids. Its consistency is invariable for the same blend when finished properly. A good soft soap should be short in texture and not show threads when drawn out. It should contain free caustic alkali within the limits of 1 to 1.5 per cent.

METHOD OF MANUFACTURE.

Linseed oil is chiefly used in making soft soap. It is readily saponified yielding a transparent amber coloured soap with a pleasant odour. Cotton seed and fish oils are also employed for the purpose. Cotton seed soap when newly made is as good as linseed oil soap but it soon acquires a rancid odour. Fish oil soaps have a fishy odour. Olive oil and coconut oil give good quality soft soap.

Soft soaps are usually made with the softer vegetable oils such as linseed oil, poppy seed oil, rape seed oil, maize oil, soya bean oil, cotton seed oil, etc. Small quantities of coconut or palm kernel oils may be used to advantage in improving the lathering features of the soap. Oils of the marine class, e.g., fish oil, whale oil, etc., are also used in making the cheaper qualities of soft soap. Rosin is usually used to the extent of 5-15 per cent. due to its agreeable odour, its keeping qualities and lathering features. Rosin is almost as hard as tallow and if used in higher percentages, the extra hardness must be counterbalanced with large proportions of the softer stocks. Castor oil yields soft soap an account of the presence in it of hydroxyacids, e.g., ricinoleic, isoricinoleic and dihydroxystearic acids. Use of this oil in large proportions will enable soft soap to be made with larger percentages of caustic soda than usual. The substitution of caustic soda by caustic potash gives still softer soaps as potash soaps are found to be very much softer than the corresponding soda soaps.

The best manipulation for saponification consists in taking the calculated quantity of caustic alkali sufficient to effect complete saponification with an excess to furnish 1 to 1.5 per cent. free alkali to the finished soap. This excess is furnished by using the theoretical quantity plus 2.5 per cent. excess calculated on the oil charge, since 100 parts of oil yield approximately 240 parts of finished soap. The process is carried out in direct-fire-pans, as during the finishing operation, brisk stirring is helpful. The caustic solution, preferably at a density of 30° Tw., is brought to boil and then the melted charge is added as quickly as can be managed without the contents frothing over. Emulsification follows with rapid saponification, and the process is usually completed with a few hours' boiling adding water when necessary. If rosin be a constituent of the charge, it is added towards the end on completion of the saponification of the other stocks. In this procedure, the quantity of the alkali, being more in excess than usual from the start, favours rapid and complete saponification. After complete saponification and gradual thickening, the soap attains a stage at which it begins to congeal, and finally assumes a neat and glossy appearance with the froth subsiding. This stage has to be regarded, if not as the exact end-point, at least the point without reaching which the soap cannot be held as finished. There is a limit to the amount of moisture that can be retained by a properly finished soap but this possibly depends on the nature of the blend. The moisture content of soft soap made from different blends, however, varies within narrow limits. The finished soap is preferably allowed to stand and cool to assume a coherent mass before being packed away.

PROCESS OF SAPONIFICATION.

The usual and orthodox process of saponification is carried out by the gradual addition of alkali, the first addition may be of a density of 23°Tw. and the final of 40°Tw. The final consistency of the soap should be regulated by the use of direct or indirect steam as required. If direct-fire-pans are used, a start may be made with a lye of 14°Tw. or so, and then 23°Tw., and ultimately 40°Tw. may be used. The end-point is tested as follows:—

If the soap on cooling has a grey colour and is dull in appearance and the mass broken or granular, then excess alkali is indicated which must be neutralised with cautious additions of further oil. If the soap has a fatty or opaque appearance, then free fat is present and should be reacted upon with cautious additions of further alkali. The finished soap must have a clean and translucent appearance which indicates a properly saponified soap containing excess of neither alkali nor fatty oil.

The softest stock found in nature other than castor oil cannot form a non-stringy soft soap with soda alone so that a soft soap charge cannot be worked with caustic soda only, if castor oil be excluded. Castor oil, by itself, can form a soft soap with caustic soda, and with the substitution of varying proportions of caustic soda by caustic potash, soft soaps can be made with castor oil in which varying proportions of other stocks have been introduced.

If it be desired to substitute more of potash by soda, it will be necessary to introduce castor oil into the blend. The percentage of caustic potash which can be substituted by caustic soda will depend on the percentage of castor oil introduced into the blend. Practical experiments indicate that about 2 per cent. of caustic potash can be substituted by caustic soda for every one per cent. of castor oil introduced into the blend, the hardness number of the charge as usual not lying beyond 175. It may be mentioned that the translucency and gloss of a soft soap are not affected if caustic potash is replaced by different percentage of caustic soda in blends containing varying proportions of castor oil.

Hardness Number of blends of soft soap should not exceed 175, if the whole of the alkali is caustic potash. With ordinary stocks the potash can be substituted to a maximum of 15 per cent by an equivalent amount of caustic soda when the Hardness Number of the charge does not lie beyond 120.

Typical Soap Charges.

Following soap charges with no castor oil will give good soft soap :—

1. Sesamum oil 50 parts ; Cottonseed oil 20 parts; Linseed oil 30 parts.
2. Linseed oil 50 parts ; Sesamum oil 30 parts; Rosin 20 parts.
3. Sesamum oil 50 parts ; Punnal oil 20 parts ; Linseed oil 30 parts.
4. Linseed oil 40 parts ; Fish oil 30 parts ; Rosin 26 parts ; Coconut oil 4 parts.

5. Sesamum oil 80 parts ; Groundnut oil 10 parts ; Cottonseed oil 10 parts.

Charges for soft soap containing castor oil in varying proportions follow :—

1. Sesamum oil 65 parts ; Cottonseed oil 23 parts ; Coconut oil 2 parts ; Castor oil 10 parts.
2. Linseed oil 30 parts ; Groundnut oil 22 parts ; Rosin 25 parts ; Coconut oil 3 parts ; Castor oil 20 parts.
3. Groundnut oil 25 parts; Rosin 25 parts ; Linseed oil 20 parts ; Castor oil 30 parts.
4. Sesamum oil 30 parts ; Groundnut oil 30 parts ; Tallow 10 parts ; Castor oil 30 parts.
5. Groundnut oil 30 parts ; Cottonseed oil 25 parts ; Mowha oil 10 parts ; Castor oil 35 parts.

Charges for soda soft soap follow :—

1. Castor oil 42.5 parts ; Groundnut oil 31.0 parts ; Linseed oil 26.5 parts.
2. Castor oil 45.5 parts ; Groundnut oil 45.5 parts ; Linseed oil 9.0 parts.
3. Castor oil 47.0 parts ; Groundnut oil 45.0 parts ; Cottonseed oil 8.0 parts.

EQUIPMENT & MANUFACTURING COST OF SOFT SOAP.

The main equipment necessary for the production of soft soap is the pan set up on a direct-fire-furnace. The most convenient size that can be used for fairly large outputs is a semi-circular one having a diameter of 72″ and a depth of 36″ with a gross capacity of 42½ mds. It is best made of a number of segments of mild steel plate, preferably 3/16″ thick, rivetted with outside strips. The pan can be readily managed with hand stirrer and a charge of 8 maunds of stock can be worked giving an output of 20 maunds of soft soap which can be completed in a working day. Smaller pans can be used, if desired, but larger ones are not recommended for difficulty in manipulation by hand. The yield from 1 maund of stock will be 2½ maunds of soft soap.

It must be pointed out that the cost will depend on the percentage of caustic potash used in the charge. If the caustic potash is increased beyond 50 per cent., the soap will be better in quality and hence will be slightly more expensive; on the other hand, if the caustic potash is reduced to 20-25 per cent., the cost will be less. In fact, to meet the demands of a cheaper quality soft soap, it will be necessary to use increasing proportions of the cheaper alkali, caustic soda.

I.

Fish oil	1	maund
Linseed oil	2	maunds
Caustic potash lye 20°Be	6	maunds

Procedure :—Take half of the oil and saponify with half its volume of potash lye of 10°Be. Send open steam and stir well. When the mass fobs add more lye and boil. Take care that the oil does not boil over. When the oil and lye are well amalgamated add rest of the oil and lye of 20°Be and boil. Add hot water to keep the mass thin. When the soap is clear and transparent, it is ready to be framed.

II.

Linseed oil	250	lbs.
Cotton seed oil	250	,,
Rosin	50	,,
Caustic potash lye, 20°Be	500	,,
Caustic soda lye, 22°Be	145	,,
Pearl ash	25	,,

Procedure :—Proceed as above. To fill in soap, first crutch in silicate of soda at the rate of 7 lbs. to the farkin (9 gallons). Next prepare a mixture of starch and caustic soda lye 24°Be. Heat to about 150° or 160°F and add farina in small quantities at a time waiting until each portion is dissolved before adding the next. The farina is added until a mass of the consistency of soft soap is obtained.

III.

Linseed oil	400	lbs.
Tallow	135	"
Rosin	50	"
Caustic potash lye, 20°Be	740	"
Caustic soda lye, 22°Be	40	"
Pearl ash	25	"

CHAPTER XIV.

MEDICATED SOAPS.

THE process of manufacturing medicated soaps is very simple. First of all, an ordinary stock soap is prepared as follows :—

STOCK SOAP.

Coconut oil	900	grams.
Caustic soda lye (10°Be)	600	„
Caustic soda lye (20°Be)	375	„
Common salt	375	„

Boil the 10°Be lye in a porcelain vessel, and gradually add the oil without stopping the heating. When the mixture has become smooth add 375 grams of caustic soda lye (20°Be). The mass now becomes thicker ; the heating is stopped when a small sample solidifies on cooling. About 500 gms. of water is then added, the whole heated to boiling and 375 grams of common salt added, when the soap will separate and rise to the surface. The mixture is then cooled, the water poured off, the mass mixed twice with a 20 per cent. salt solution, and finally with cold water. The water is allowed to drain off in a hair sieve and the mass pressed to remove the excess of water. The soap so obtained is in the form of a paste, which is brought to a suitable consistency by a very moderate heat in a drying oven, in order to enable the selected medicament to be incorporated, after which the soap may be pressed into tablets and dried at a temperature of from 30° to 35°C.

The best way of preparing medicated soap is however that done by the milled process.

SOAPS FOR SKIN DISEASES.

Take 9 parts of this stock and add to it 1 part of soda ichthyol, dissolved in as little water as possible and incorporate thoroughly. This soap is very suitable for rheumatism, sciatica, burns, and various skin diseases.

CARBOLIC SOAPS.

For this class of soaps almost any good stock soap may be used, but this is usually varied according to the quality or grade of the soap. Thus, the lowest grades of these soaps are made from the nigers of pale soaps mixed with fresh stock soap. The best grades of these soaps are made from good pale soaps made from tallow, bleached palm oil and rosin. As carbolic acid has a slight acid reaction, it is a wise plan to leave the soap stocks slightly alkaline, otherwise, if quite neutral the acid may cut the soap during the mixing. The usual quantity of carbolic acid added to soap varies from 5 per cent to 10 per cent. Excess of it may cause skin irritation. This is the minimum quantity which should be added, otherwise the medicinal value of the soap will be inappreciable. For colour effect use metanil yellow.

For pale carbolic soaps the best crystal acid should be used. Before adding to the soap, this may be mixed with a small quantity of water or alcohol to render it liquid. For the commoner class of carbolic soaps, which usually are of a dark brown colour, the crude carbolic acid may be employed. The process is simple, the stock soap being run off and fitted if required, the carbolic acid is crutched into it in the crutcher, adding it little by little. After crutching the soap is framed and allowed to set, after which it may be cut up into bars and stamped in the ordinary manner.

As carbolic acid is a volatile substance it will gradually evaporate off on storage unless suitably wrapped. The phenols have a softening effect on soap which is increased by their hygroscopic nature and, therefore, it is desirable to dry these soaps well, and to market them in a moisture-proof pack.

I.

First prepare stock soap according to the process described on (*p. 167*). Now 50 grammes of carbolic acid is dissolved in 25 grammes of alcohol and the solution gradually added to 950 grammes of the stock soap already prepared. Add metanil yellow (2 dr. for 100 lbs.) dissolved in water. The mixture is then made homogeneous by thorough incorporation. It is then cut and pressed into tablets and dried at a temperature of from 30° to 50°C.

II.

First melt pale soap and crutch in about 2 per cent. of carbolic acid in crystals. Place in a frame, and when cold cut into squares, mould and pack.

III.

First of all a soap basis has got to be prepared. The cold process may be adopted for this purpose with 10 lbs. Cochin coconut oil and 5 lbs. soda lye (38°Be). Next 6 oz. pure carbolic acid is dissolved in a similar quantity of potash lye and the solution stirred up with 8 oz. glycerine (28°Be.). The whole mixture is then added to the soap and thoroughly incorporated. The proportion of the acid may be varied to obtain the desired strength of the resulting soap.

IV.

Coconut oil	80	lbs.
Tallow	40	,,
Caustic soda lye (38°Be)	60	,,
Phenol	3	,,

Melt the coconut oil and tallow together by gentle heat. Then raise the temperature of the mixture to

35°C and stir in the caustic soda lye. Continue stirring until the soap becomes sticky. Now dissolve the phenol in a little water and crutch well into the soap. Perfume the soap if desired with a little clove oil, lavender or rosemary oil. When the soap sets hard, cut into tablets and wrap in an air-tight package.

NEEM SOAP.

Coconut oil	5 seers
Neem oil	1 seer
Caustic soda (70°-72°)	1 seer
Water	2 seers
Victoria blue	3 mashas
Uranine yellow	½ masha

Procedure :—Dissolve the caustic soda in water and allow the solution to cool. Now in another vessel mix the oils and then slowly add the caustic soda lye with continuous stirring. When the whole mixture has acquired the consistency of thick paste the colours are intimately incorporated into it after being finely ground and the creamy substance is subsequently set aside for 48 hours to settle. The soap formed in this manner is next cut into suitable pieces and moulded.

CHAULMOOGRA SOAP.

By Cold Process.

I.

Coconut oil	20	seers
Castor oil	2	„
Neem oil	1	seer
Caulmoogra oil	3	seers
Caustic soda lye 36°Be	15¼	„
Soda green	2	dr.
Dissolved in boiling water		q.s.
Ichthyol	1	lb.
Thyme oil	4	oz.
Oil citronella	4	oz.

Procedure:—Fresh and clear oil and clear lye should be taken. The oil should just be in melted state and not hot but the lye should be cold. Dissolve colour in boiling water but don't boil. Rest of the procedure is as usual.

II.

Coconut oil	24	lbs.
Castor oil	1	lb.
Chaulmoogra oil	2	lbs.
Neem oil	½	lb.
Caustic soda lye 36°Be	16	lbs.
Sulphur sublimate	1	lb.
Windsor brown	10	gr.
Dissolved in boiling water		q.s.
Oil citronella (Java)	2	oz.
„ rose geranium	2	„
„ cloves	¼	„
„ sandal	¾	„

Procedure :—Mix the first four oils. Throw in sulphur dust gradually and stir so as to incorporate it thoroughly with the mixture ; then add the lye and colour and go on stirring until the mass is nearly thick. Then add the perfume and mix well by stirring and frame.

By Semi-Boiling Process.

Procedure :—First saponify coconut and castor oil with the lye as usual. Melt separately ½ seer of rosin with the neem and chaulmoogra oil and mix ichthyol and thyme oil with it. Then add this to the soap and mix well. Finally mix colour and citronella oil and frame.

By Milling Process.

Stock soap (of hard consistency)	95	lbs.
Oil chaulmoogra	5	„
B Naphthol	1	lb.
Sulphur sublimate	2	lbs.

English brown	2	dr.
Dissolved in boiling water		q.s.
Oil lavender	3	oz.
Oil rose geranium	2	„
Oil sandal	1	„

Procedure :—Mix medicines, colours and perfumes during the process of milling.

CRESOL SOAP.

Although cresol is hardly soluble in water, it dissolves readily in potash soaps, the resulting mixture being then miscible in all proportions with water. Cresol soaps are even more powerful than carbolic soaps and are at the same time less corrosive and poisonous to the human system.

Lysol soap has for its basis lysol which is 10 per cent. solution of an alkali cresol salt.. A mixture of equal parts of cresol and Turkey red oil, which is water soluble, is sometimes compounded with soaps.

NAPHTHALENE SOAP.

Coconut oil	5	seers
Caustic soda (70°—72°)	1	seer
Water	2	seers
Naphthalene balls	14	chtks.

Procedure :—Powder the balls thoroughly and pass them through some linen. This can be prepared by hot as well as by cold process. Dissolve the caustic soda in 2 srs. of water and gradually pour over the oil and stir gently until a thick paste is obtained. Next thoroughly incorporate the naphthalene powder and set aside for a day or two. Then the soap thus formed is cut and stamped.

NAPHTHOL SOAP.

Add 5 gms. B-Naphthol dissolved in 50 c.c. alcohol to 95 c.c. of white soap stock.

CAMPHOR SOAP.

Camphor soaps are used for chilblains and in the bath for rheumatic pains.

(1) *Soft Camphor Soap* is made by dissolving 5 to 10 per cent. of camphor previously dissolved in alcohol in melted "soft soap." It is used as a salve for sores, etc.

(2) *Milled Camphor Soap*—Add to 25 lbs. of melted white stock soap 2 lbs. of camphor dissolved in spirit and incorporate thoroughly.

Cut the soap into tablets and wrap tightly in paper and tinfoil as camphor is volatile.

BORAX SOAP.

Borax Dry Soap—25 lbs. soap, 50 lbs. soda crystals, 15 lbs. borax, 10 lbs. refined alkali.

Borax Soft Soap—Tallow or fat 20 lbs., soda lye (15°Be) 20 lbs., potash lye (10°Be) 12 lbs., solution of borax (10°Be) 3 lbs.

The soda lye is added to the melted fat and heated till it forms a clear liquid or is combined when the potash lye and borax solution are added. It should be a semi-solid translucent paste, and is usually sold in quart cans.

Borax Bath Soap—First prepare the coconut oil soap required for this purpose according to the following process.

Put 100 lbs. of coconut oil and 100 lbs. of caustic soda lye 27°Be into a soap kettle; boil and mix thoroughly for 2 to 2½ hours, until the paste gradually thickens; then diminish until the cooling paste assumes a white, half solid mass, then transfer quickly to the frames. Finally mould as desired.

Add 100 parts of borax to 900 parts of coconut oil soap, and mix until a homogeneous mass is obtained; cut into pieces of required size and press and dry the pieces.

Borax Soap Powder—Take Curd (hard) soap powder 5 parts ; Soda ash 3 parts ; Silicate of soda 2 parts ; Borax 1 part. Each ingredient is thoroughly dried, and rendered into fine powder and these are then mixed together by sifting.

IODINE SOAP.

Iodine cannot be added to soaps as it is not stable and soaps change colour from brown to a light yellow in course of a short time. A right way of introducing iodine is to add it in the form of a compound with an unsaturated acid, such as oleic acid.

Iodine soaps are also prepared with adding to the melted soap 6 to 7 per cent of potassium iodide dissolved in a small quantity of hot water together with ½ per cent sodium bisulphite.

Completely saponify 20 ℔s. coconut oil with 10 ℔s. caustic lye of 40° Be and then incorporate a solution of 3 ℔s. of potassium iodide in 4 ℔s. of water.

MERCURIAL SOAP.

This is sometimes prepared for treating dogs and other animals, and for preserving skins in taxidermy. It contains corrosive sublimate. One drachm of the latter compound is dissolved in a mortar with 1 oz. of rectified spirit, and 4 oz. of a good soap, cut up into fine shavings, is added. The whole is then incorporated by careful grinding.

SULPHUR SOAP.

Sulphur soaps contain sulphur in its most oxidisable state, i.e., flowers of sulphur. It is used in combination with certain pine oils (terpenes) with alkali sulphide. The solution of the clear brownish liquid in water gives a white emulsion. Ichthyol and ammonium ichthyol sulphonate are used to about 5 per cent.

I.

A soap containing sulphur is largely used for washing dogs, and also for treating various forms of skin diseases. These soaps are very simply made; a good white soap made from tallow and coconut oil is employed, and into it while melted, after it has been fitted, are stirred flowers of sulphur 10 to 20 ℔s. to 1 cwt. of soap, a little perfume being added to impart an odour to the soap.

II.

Coconut oil soap	9 parts
Sublimed sulphur (finely sifted)	1 part

Procedure :—Incorporate the sulphur to the soap until a homogeneous mass is obtained; then cut into pieces and press in moulds.

TOOTH SOAP.

Tooth soaps are formed from a well-made and neutral tallow soap, adding to it, while in a molten condition, finely sifted siliceous earth powder, prepared chalk and starch. The following quantities may be taken as a guide; 20 ℔s. of soap, 1 ℔. of siliceous earth powder, 2 ℔s. of chalk, and ½ ℔. of starch. The ingredients are then mixed intimately. Flavours may be added, if desired.

COAL TAR SOAP.

In making coal tar soaps use is made of naphthalene, naphthol, etc. in addition to carbolic acid. An excess of naphthalene is to be avoided or the soap will be unpopular for strong odour. The odour of the coal tar is considerably modified and blends well with a perfume containing oils of cassia, lavender, spike and red thyme. Take coconut oil soap scraps 30 parts, dissolve in solution of salt of 10°Be and stir about 3 parts of coal tar. Or melt together 20 parts coconut oil and 3 parts tar and saponify with caustic soda of 40°Be. The soap is used for skin and other cutaneous diseases.

TAR SULPHUR SOAPS.

I.

Tar sulphur soap may be prepared by dissolving 2 lbs. of potassium sulphide in a small amount of water, and adding it to 20 lbs. of yellow stock soaps together with 4 lbs. of birch tar oil. The mass is milled several times until the soap is uniform.

II.

Melt 20 lbs. of coconut oil and mix in it 2 lbs. of flower of sulphur at 25°-30°C. Next mix in rapidly 12 lbs. of caustic soda lye of 28°Be. When combination is effected add 4-8 oz. of rosemary oil, and finally stir in vigorously 8 lbs. of wood tar. Immediately frame the soap.

III.

Dissolve 2 lbs. of potassium sulphide in as little water as possible and add to 20 lbs. of yellow stock soap. Next add 4 lbs. of birch tar oil and pass the mass several times through the milling machine until the ingredients are thoroughly mixed. A brown soap is obtained. Cheaper wood tar may be used instead of birch tar oil but this does not make such a good soap.

WOOD TAR SOAP.

Melt 40 lbs. of yellow or brown soap stock and mix with 5 lbs. of wood tar which has been neutralised with alkali in a steam jacketed crutcher. Then pour into frames and cut into slabs and stamp.

By Cold Process.

Tallow	271	lbs.
Coconut oil	271	,,

Soap Scrap	180	lbs.
Pine tar	73	,,
Caustic soda lye 36°Be	340	,,
Sodium silicate	36	,,
Pearl ash lye 36°Be	9	,,

Place the tallow, coconut oil and pine tar in a steam jacketed crutcher and heat to 180°F. Add the scrap soap and melt completely. Now run in the mixed lye, add sodium silicate. Crutch for 5 minutes, allow to stand for one hour, and crutch again until combination is complete. Now add the pearl ash solution and crutch until the soap becomes thick and smooth, then run out the mass into the soap frame and allow to cool.

THYMOL SOAP.

Coconut oil	1	dram
Potassium hydroxide	1	,,
Sodium hydroxide	1	,,
Thymol	5	grains
Distilled water to produce	6	ounces

Dissolve the sodium hydroxide in one ounce of distilled water and dissolve in a separate vessel the potassium hydroxide in another ounce of water. Now place the coconut oil in a suitable pot and pour the sodium hydroxide solution stirring vigorously until all the sodium compound has been absorbed by the oil. Then add the potassium hydroxide solution and again stir so as to saponify the whole of the coconut oil. Then incorporate the thymol and allow the soap to stand for 15 minutes. Afterwards add the remainder of the distilled water.

II.

Dissolve 3 gms. of thymol in 30 c.c. of alcohol and crutch in 97 gms. of white soap base.

TANNIN SOAP.

Dissolve 3 gms. of tannin in 50 c.c. of alcohol and crutch in 95 gms. of soap base.

MENTHOL SOAP.

Menthol	1	gm.
Dissolved in spirit	10	c.c.
Soap base	40	gm.

FORMALDEHYDE SOAP.

Formalin	1	gm.
Dissolved in Alcohol	10	c.c.
White soap base	99	gm.

GERMICIDAL SOAP.

Sodium Silicate	3	gm.
Dry Sodium Abietate	15	,,
Sodium hexametaphosphate	13	,,
Soda ash	15½	,,
Sodium chloro-o-phenyl phenolate	1	,,

Use 1 gm. of above per 100 c.c. water at 45°C.

SURGICAL SOAP.

Corn oil	700	lbs.
Soap Stock Base	75	,,
Caustic Potash	137.6	,,
Water to make	134.0	,,

CHAPTER XV.

SHAVING SOAPS.

THE primary requisite for a good shaving soap is that it should produce a good and persistent lather which, when formed on the face, will remain practically permanent. Its action on the skin must at the same time be neutral. Naturally therefore considerable care is required to make a soap possessing these qualities. The best fats for the purpose are tallow and coconut oil, and it is advisable to use both soda and potash in their preparation as better lathering soaps are obtained in this way. Both the cold and the boiling processes are applicable in the manufacture of shaving soap. Here are a few reliable recipes :—

I.

Tallow	100	℔s.
Coconut oil	12½	„
Soda lye of 38°Be	50	„
Potash lye of 38°Be	6	„

Procedure :—Proceed in the usual way as for making toilet soap ; add any desired scent in suitable proportions. Sometimes a little gum tragacanth (1 ℔. per cwt.) is introduced during the process to make the lather of the product more permanent.

II.

Tallow	250	parts.
Coconut oil	125	„
Lard	25	„
Caustic soda lye of 30°Be	275	„
Caustic potash lye of 20°Be	75	„
Oil of lavender	1	part.
Oil of thyme	½	„
Oil of cumin	½	„

Procedure :—Melt together tallow, coconut oil and lard and allow the mixture to cool off to 115°F. Then add the caustic soda lye and caustic potash lye with gentle stirring and perfume the soap with the oils stated above. Set aside for a day and then cast into sticks by means of moulds.

III.

Tallow oil soap	75	lbs.
Coconut oil soap	50	„
Oil of carraway	6	oz.
Oil of bergamot	6	„
Oil of lavender	3	„
Oil of thyme	3	„
Oil of cloves	1	„

Procedure:—Remelt the soaps and incorporate the perfumes. Finally cast into sticks by means of moulds.

IV.

	A.	B.
Tallow	2½ mds.	2½ mds.
Coconut oil	12½ seers.	20 seers.
Caustic soda lye (37°Be)	1¼ mds.	52 seers.
Caustic potash lye (37°Be)	6 seers.	2 seers.

Procedure:—Heat the tallow and oil to 100°F and add the lyes as usual until the mass forms a well-combined homogeneous paste. The entire operation takes 15 to 20 minutes. It is finished when the surface of the soap becomes covered with a film which constantly re-forms notwithstanding stirring.

Perfume the soap with oils of lavender and thyme, each 3½ ounces, oil of cumin 7 ounces, oil of bergamot 10½ ounces or any mixture of essential oils to obtain the desired flavour. The perfume is added to the soap, in suitable proportions with constant stirring, before bringing it into the frame.

V.

Tallow, white	80	lbs.
Coconut oil	40	
Caustic soda lye (30°Be)	64	
Caustic potash lye (30°Be)	16	

Procedure:—Proceed as in (IV) and add suitable perfumes.

WHITE SHAVING SOAP.

In making white shaving soap use is made of coconut oil and stearic acid to the exclusion of tallow. A formula follows:—

Coconut oil (Cochin)	300	lbs.
Caustic soda lye 35°Be	40	,,
Caustic potash lye 50°Be	550	,,
Glycerine	80	,,
Stearic Acid	1050	,,
Titanium dioxide	q. s.	

The coconut oil is run into a crutcher and heated to about 125°F. Then the previously melted stearic acid is added. Next the potash and soda lyes are run in and crutched until it assumes the consistency of thin dough. In the meanwhile add glycerine. When thoroughly mixed, pour into frames. Then have the soap milled and plodded together with a suitable perfume. Add some titanium oxide to whiten it.

SHAVING SOAP POWDER.

Shaving soap powders are pure curd soap pulverised and mixed with starch, almond paste, or powdered orris-root. These additions serve a double purpose; many very sensitive skins cannot even bear pure neutral curd soaps, their use causing an unpleasant sensation of dryness. This is alleviated if soaps with the above additions are used, their presence also causes the lather to be more permanent. By mixing 20 to 25 parts of starch with 100 parts of soap powder a shaving powder is obtained which gives a fine, permanent lather. This powder is generally supplied white, but it is also coloured rose by mixing a little cinnabar in it. Before mixing the starch into the powdered soap it is perfumed and, if necessary, coloured, the colour and perfume being very carefully ground up, and when thoroughly mixed up the whole is passed through a not too fine sieve. If the perfume is added to the powdered soap it forms small balls which in spite of all trouble cannot be entirely got rid of, and finally remains upon the sieve.

The perfume usually employed for white shaving powders made with starch is a mixture of lavender oil, oil of thyme, oil of carraway and fennel oil; for rose powder—geranium oil, palmarosa oil, and a little oil of cloves, and for finest rose shaving powder—geranium oil, rose oil, and bergamot oil.

CHAPTER XVI.

TEXTILE SOAPS.

WOOL SOAPS.

WOOL soap is used to scour the wool, *i.e.*, to extract the dirt and grease from the wool prior to spinning. The soap is made slightly alkaline, the proportion of the free alkali not exceeding 1 per cent.

The soap is made from low grade fats and oils; colour and quality are not of much importance. This does not require the same amount of care as the household soap.

The better quality wool soaps are made with caustic potash instead of caustic soda. In this case the soap is soft and wool washed with it has a silky appearance and feels soft. This also does not turn yellowish.

CALICO PRINTERS' SOAP.

The calico printers use soap to clear the printed cloths from the thickening used during printing and for brightening the colour. The soap for the purpose must be soluble in water without foul odour and quite neutral. The presence of acids to an extent exceeding 0.2 per cent. is not allowable.

The best oils to make soaps for this purpose are bleached palm oils and olive oil. In their absence coconut oil or castor oil may be used but the soap has often got an offensive smell. No rosin is used in the preparation of this soap. The soap should be soluble so that the soap can be washed out after treatment.

The soap should be made carefully. Complete saponification is necessary by boiling on strength (*p.* 48) and finally it is to be made neutral fitting (*p.* 49).

SILK SOAP.

This is intended to free the raw silk from the gummy matter it naturally contains. The soap should be soluble in water and contain free alkali not more than 0.4 per cent. Olive oil is the best ingredient to be used. Coconut oil may also be used but the soap is hard to be neutralised and is not quite odourless. Groundnut oil may be used for the purpose. The soap should be fully saponified and leave no fat unconverted.

DYERS' SOAP.

The soda soaps or hard soaps are chiefly used in dyeing. The soap must be neutral, *i.e.*, it should be free from unsaponified fat and it should not contain any uncombined alkali.

MONOPLE SOAP.

Monople soap is largely used by the dyers to brighten shades. Addition of ½ to 1 per cent. of the soap while dyeing substantive dye-stuffs, especially when hard water is available, gives excellent results. The special claim made for it is in respect of its use in place of Turkey-red oils in the dyeing and printing of cotton goods and finishing of textile fabrics.

The soap is prepared by heating the sulphonated oil (obtained on treatment of castor oil with sulphuric acid) with alkali. Care should be taken to finish the soap neutral or slightly acidic so that it is not affected by direct solutions of acids or concentrated salt solutions.

The soap, if properly done, should not form precipitate with lime and magnesium salts, because the salts formed are soluble in excess of the soap. The product is not precipitated when used in the dye bath as in the case of the ordinary soap, nor is it deposited upon the fibre.

270 kilos of castor oil are sulphonated with 60 kilos of concentrated sulphuric acid. The sulphonated oil is then well-washed in water and salt solution. About 300 kilos of sulphonic acid is obtained therefrom.

Now 12.5 to 13.5 kilos of soda ash dissolved in water are added at ordinary temperatures until the product is neutral and dissolves in water to form a clear solution. Thereby sodium salt of the sulphonic acid is formed.

The above salt is now heated in a boiler until water vapours cease to be evolved. The temperature is raised to 130°C and on cooling a viscid neutral oil is obtained which is otherwise known as monople soap.

This oil dissolves in water forming a clear solution which lathers well. The product is soluble in petroleum spirit, benzene, ether, etc. and in mineral and fatty acids.

CASTOR OIL SOAP FOR PARA RED.

Mix 20 lbs. castor oil (of the first pressing) with 17 lbs. caustic soda lye, 22°Be, and boil for 1 hour, allow the soap to cool for about 5 hours, then add 4 lbs. 14 oz. hydrochloric acid, 20°Be, boil for ½ hour, allow to cool, and syphon off the salt solution.

MARSEILLES SOAP.

The best Marseilles soap is a green olive oil soap, made from sulphonated olive oil. This is made to contain 62 to 64 per cent. of oil, with a corresponding proportion of alkali and water. In the absence of olive oil tallow or coconut oil may be tried.

Olive oil soaps are fairly soluble, and leave no unpleasant odour behind them. They are employed in dyeing with substantive dye-stuffs and in soaping dyed materials.

DYE SOAP.

I.

Dye soap is prepared by taking 1 ℔. of common white or coloured yellow soap, mixing with it aniline 1 drm. and dissolving it in 2 oz. of gin and 2 oz. of water, then working up the mass in a clear paste and moulding it to the desired shape with stamps on.

II.

Melted soap	1	cwt.
Aniline dye	1	℔.
Boracic acid	3	%
Glycerine	5	%
Egg albumen	1	%

Dissolve the boracic acid in boiling water, crutch well in the melted soap, then crutch in the colour and glycerine mixed with the albumen. When the soap is nearly cold, run into moulds.

COTTON PRINTERS' SOAP.

Marseilles soap	200	parts
Tallow soap powder	95	
Soda ash	20	
Borax	10	
Turpentine	25	
Potassium hydroxide	20	
Dissolved in Water	30	

Use 40 parts in 1000 parts of water for washing of fabrics.

DRY CLEANING SOAP.

Oleic acid	5	parts
Caustic potash	1	part
Methylated spirit	4	parts

Mix oleic acid and caustic potash and stir until an emulsion is produced. Then dissolve it in methylated spirit. This soap is freely soluble in benzine. By increasing the quantity of oleic acid the solubility of soap in benzine is increased.

II.

Oleic acid	7	lbs.
Hexalin	4	
Caustic potash	1½	
Water	8½	

III.

Oleic Acid	46	parts
Caustic Soda (25 %)	27	„
Alcohol (95 %)	43	„
Trichloroethylene	900	„

Saponify oleic acid with caustic soda at elevated temperature on a water bath. Add alcohol and reflux to clear solution which is stirred into tri-chloroethylene and let cool. This makes a good dry-cleaning fluid.

CHAPTER XVII.

MISCELLANEOUS SOAPS.

METAL POLISHING SOAP.

A GOOD polishing soap may be made by mixing 100 lbs. of coconut oil soap (with sufficient water to make it fluid) ; 10 lbs. tripoli powder ; 5 lbs. of alum ; 5 lbs. of cream of tartar ; and 5 lbs. of dry whiting. These should be pulverised together, and cast into cakes.

PETROLEUM OR PARAFFIN SOAP.

Soaps from paraffin oil (and other mineral substances) are made by crutching into a soap paste 10 to 20 per cent. of petroleum oil. The addition of these products to a laundry soap appears to increase its detergent effect, and greasy cloths in particular are more readily washed with paraffin soap than with an ordinary soap. Sometimes the mineral oils are not used ; but instead a soft, low-class, and somewhat oily paraffin wax is employed on account of the odour being less.

DEPILATORY SOAP.

The following are good recipes for soaps meant to remove hair.

I.

453 grms. of glycerine, 907 grms. of coconut oil and 1844 grms. of castor oil are saponified with 1814 grms. of 33°Be caustic potash lye as previously explained. The soap is then filled with 113 grms. of starch and 907 grms. of sulpho-hydrate of sodium, and perfumed with citronella oil.

II.

Soap Base	2	seers
White Starch	1	seer
Barium Sulphide	2	seers

Prepare soap base as explained on *p. 167* and while in paste form incorporate the other two ingredients in fine powder. Mix intimately to have uniform mass and mould.

SADDLE SOAP.

I.

To make saddle soap, gently heat over a slow fire, constantly triturating till thoroughly incorporated, 1 ℔. of beeswax, 8 oz. of soft soap, 2 oz. of linseed oil, and ½ pint of oil of turpentine. Put in pots or tins. Rub very well into the saddle and finally polish with a soft brush.

II.

Palm oil	14	parts
Rosin, Light	1	part
Caustic soda 38°Be	7	parts
Water	35—40	,,
Glycerine, 30°Be	5	,,
Talcum	0.2	part

Melt the first two and saponify in the usual manner with caustic soda to the desired consistency. Add water and glycerine and finally talcum. Allow to cool in moulds. Some of these soaps contain 1 to 2 per cent beeswax.

DOG SOAP.

I.

Potassium hydroxide	4.05	parts
Water	6.15	,,
Linseed oil	18	,,
Cresol	1.55	,,
Alcohol		to clear

Dissolve the hydroxide in water and add the liquid to the oil. Then add alcohol and let stand at room temperature shaking intermittently until saponified. Finally add cresol and mix until dissolved.

II.

Petroleum	50	grms.
Wax	40	,,
Alcohol	50	c.c.
Good laundry soap	150	grms.

Heat the petroleum, wax and alcohol in a water bath until they are well mixed; and dissolve in the mixture the soap cut into fine shavings and lastly pour into wooden moulds.

LIQUID DOG SOAP.

Coconut oil	10	parts
Caustic potash (50°Be)	5.3	,,
Water	3	,,
Potassium carbonate	1	part
Calcium chloride	1	,,
Sugar	10	parts
Water	46	,,
Liquefied phenol	4	,,

Heat coconut oil to 50°C. Add caustic potash and water and keep hot till saponification is finished. It must be first alkaline to phenolphthalein. Add liquefied phenol and hot solution of the rest of the ingredients. Cool, and filter through glasswool.

STAIN-REMOVING SOAP.

Take 100 Ibs. of talc made to a paste with weak solution of carbonate of potash and mix this with 1,000 Ibs. of rosin grained soap by heat. When cool enough add 4 Ibs. of turpentine and 3 Ibs. of benzine. Finally mould.

SCOURING SOAP AND POWDER.

Scouring soaps are generally made on a coconut oil base. The soap after saponification is drawn to a crutcher, silex (grit) is mixed with it and the mass dropped into an asbestos-jacketed kettle or tank and run into slate moulds to harden, each mould being the size and shape of the finished soap.

II.

	Olive oil	2	lbs.
	Oleic acid	2	„
	Tallow	2	„
	Water	½	lb.
(1)	Caustic soda lye 40°Tw	5	lbs.
(2)	Caustic soda lye 25°Tw	5¾	„

Put the oils and fat in a pan fitted with open steam; run in the water, turn on steam and start in the No. 1 lye. Keep up gentle boiling till whole of the lye is run in; boil for about 2 hours. Now add the No. 2 lye gradually, boiling for another 2 hours. Add sufficient common salt to set free the half-spent lye, boil till the lyes are quite free from goods, let rest all night, and run off through a valve fitted at the bottom of the pan. Now turn on again open steam and boil for another 2 hours. Lastly allow it to rest till next day when it is ready for the frames.

III.

Scouring powder is made by mixing varying amounts of soap powder, silex (grit), talc and sometimes a small amount of sal-ammoniac.

PEROXIDE SOAP.

Many efforts have been made to manufacture soaps containing active oxygen, as such soaps have valuable disinfecting and bleaching properties. According to one method, coconut oil, prior to its use in the manufacture of soap by the cold process, is treated with ozonised air. The soap manufactured from this product has an oxidising and antiseptic action and is free from the peculiar smell of coconut oil.

According to another method, the free fatty acids are used and these are allowed to act at 100°C upon alkali salts of peracids such as sodium percarbonate, perborate, persulphate, etc. It is very remarkable that these persalts are not decomposed at 100°C during the operation. The soap thus obtained has bleaching and disinfecting properties.

CASTILE SOAP.

Olive oil	500	℔s.
Palm oil	1000	„
Tallow	350	„
Cotton seed oil	350	„
Caustic soda lye (280°Be)	150	gallons.
„ (42°Tw)	150	„

Take half the lye at 28°Tw., and the other half of lye at 42°Tw. Put the lye, say 150 gallons at 28°Tw. into the pan ; heat by steam or fire to about 150°F, add the oil and agitate until it commences to boil. Boil, say, 3 or 4 hours, or until the oil has taken up the whole of the alkali. Then throw in salt until the soap separates ; allow the spent lye to settle to the bottom of the pan and draw off. Kindle the fire again and when boiling add gradually, say 20 to 30 gallons lye at 42°Tw., at a time, until the soap begins to boil clear, and continue adding the lye until finished. Now cut the soap, and draw off the spent lye—this contains the glycerine—when settled. Boil up again briskly, and add a little water; this is to wash the soap and give it a clear, marble-like appearance.

CURD SOAP.

Curd soap (*p. 5*) is prepared by saponifying ordinary tallow with caustic soda (*p. 44*). On the completion of the operation the mass is grained out (*p. 46*) with salt. The soap separates out from the waste lye which settles at the bottom of the pan. The pan is set aside for a few hours and the waste lye is withdrawn. The soap is next boiled with stronger lye. The soap opens and appears like curd separating from the mills. The lye runs off from the soap which is insoluble in moderately strong alkaline solution. When the soap acquires a proper consistency the curd is allowed to settle for a while and then put into frames and allowed to cool.

MARINE SOAP.

Marine soaps are for use in the sea and as such they should be soluble in sea water. These soaps contain as much as 80 per cent. water.

Marine soap is usually made from coconut oil, and cotton seed oil or groundnut oil. The soap is usually made by the cold process or the semi-boiling process and is filled with large quantities of brine and carbonate of soda to increase the hardness and with silicate of soda to increase the detergent action. When the semi-boiling process is followed it is usual to boil the soap after liquoring (*p. 94*). The soap is well crutched and then framed.

I.

Coconut oil	5	seers
Caustic soda lye, 62°Tw	2¾	,,
Salt brine 20°Tw	4	,,

Put the coconut oil into a suitable vessel and apply heat. Add the lye gradually and continue heating after saponification has taken place, which should be in about two hours, add the salt brine to the soap in the vessel, boil for half an hour, and it is ready for the frames.

II.

Coconut oil	25	seers.
Castor oil	3	,,
Caustic soda (38°Be)	15	,,
Water	10	,,

Sodium silicate (36°Be)	25	seers
Potassium carbonate (30°Be)	8	,,

III.

Coconut oil	50	seers
Caustic soda (30°Be)	60	,,
Sodium silicate (38°Be)	20	,,
Turkey red oil	5	,,
Potash solution (30°Be)	15	..

SAND SOAP.

I.

Saponify 50 ℔s. of coconut oil with 100 ℔s. of soda lye of 20°Be. The soap is then hardened by the addition of about 8 ℔s. salt dissolved in water to a density of 15°Be, with the addition of 6 to 8 ℔s. soda ash. Cover up and allow to cool. After standing 5 to 6 hours the fob is skimmed and the soap mass is put into frames. 100 to 150 ℔s. of dried and sifted salt is then crutched in, which should be continued till the soap cools. The soap is very firm and hard and must be cut as soon as cooled. To perfume the mixture add oil of lavender, oil of thyme and oil of coriander, each 100 grms.

II.

Coconut or Palm kernel oil	50	kg.
Caustic soda (38°Be)	26	,,
Water	4	,,
Fine sand or pumice	30	,,
Spike oil	150	g.
Rosemary oil	100	,,
Caraway oil	30	,,
Peppermint oil	25	,,
Ultramarine		q. s.

The perfume should be added to the melted fats, since the soap gets heavy too rapidly.

VASELINE SOAP.

Take 160 parts coconut oil, 20 parts vaseline, 76 parts of lye of 40°Be and 4 parts water and proceed as usual.

TANNIN SOAP.

Dissolve 30 ℔s. tallow soap; add 2 ℔s. of tannic acid and enough starch to form the mass into cakes.

CARPET SOAP.

To make carpet soap take fullers' earth 40 oz., spirit of turpentine 1 oz. and pearl ash 8 oz. Rub smooth, and make into a stiff paste with a sufficiency of soft soaps.

OATMEAL SOAP.

Take white soap 25 ℔s., coconut oil soap 16 ℔s., and remelt and crutch in 6 ℔s. of coarse ground oatmeal.

HONEY SOAP.

It is nothing but an ordinary tallow soap mixed by means of a stirring apparatus with 10 times its weight of infusorial earth, and pressed into cakes weighing 1 ℔. each. It is used for cleaning metals, glass, etc.

FLEECE WASHING SOAP.

Take 20 ℔s. of caustic potash in an iron or eathenware vessel with 20 ℔s. of water; the mixture must be used only warm or about 90°F. Melt 80 ℔s. of tallow free from salt; the heat of this must be about 120°F. Now pour the potash lye gently into the tallow, stirring it with a wooden spoon. Pour off into mould.

SILEX SOAP.

It is nothing but an ordinary tallow soap mixed by means of a stirring apparatus with 10 times its weight of infusorial earth, and pressed into cakes weighing 1 ℔. each. It is used for cleaning metals, glass, etc.

MOLASSES SOAP.

100 parts of molasses are heated in a boiler provided with close serpentine steampipes, and 28 parts of ordinary calcined soda are then added under constant stirring. As soon as solution is complete, 100 parts of oleic acid are carefully added so that the carbonic acid of the soda, which is liberated, first escapes. When all the oleic acid has been added, the compound is for a short time heated to the boiling point. The process is very quick, it being possible to produce 20,000 ℔s. of soap in 2 hours. 100 parts of molasses yield 210 to 225 parts of soap which according to the time of boiling, is either half or entirely hard.

SOAP PAPER.

The material for impregnating the paper consists of 10 parts of glycerine, 30 of alcohol, 60 of dry glycerine soap and 50 of ordinary dry neutral soap at a temperature varying between 162° and 180°F. In the trough containing the mixture are three rollers revolving in the same direction, over the lower side of which paper is passed. During the manipulation a thin spray of oil of turpentine is allowed to fall upon the paper, which makes it dry more quickly and gives it a lustrous appearance.

SOAPS CONTAINING CHLORINATED HYDROCARBONS.

(a)	Hard Soap	50	℔s.
	Soft Soap	200	,,
(b)	Glycol Monomethyl Ether	40	,,
(c)	Carbon Tetrachloride	200	,,

Mix (a) thoroughly (hot), add (b) and add in (c) with good mixing thereafter. A still gel. Clearly water-soluble.

LIQUID DENTAL SOAP.

Olive Oil		70	g.
Caustic Potash (38°Be.)	about	35	„
Alcohol		280	„
Glycerin		230	„
Water		350	„
Perfume		35	„

Saponify the oil with the caustic potash which is dissolved in about an equal weight of the alcohol. To the soap formed add the water and the glycerin with good agitation, both being warmed up before the addition. Let stand for some time in the kettle to cool. Add the rest of the alcohol and the perfume with good agitation. Let settle for 8—14 days in smaller vessels. Filter.

RUG CLEANERS' SOAP.

Trisodium Phosphate	23	oz.
Borax	27	
Sodium Metasilicate	3	
Soda Soap	30	
Soda Ash	8	
Para-dichlorbenzene	3	

CHAPTER XVIII.

ANALYSIS OF SOAP.

THE samples for soap analysis should not be taken from the skin which is formed on the surface due to exposure to air.

The chief matters of investigation in soap analysis are :—

1. Determination of the amount of fatty acid present.
2. Determination of free alkali present in the soap.
3. Determination of the percentage of water present in the soap.
4. Determination of carbolic acid, silicate, sodium chloride, etc. present in the soap.

DETERMINATION OF FATTY ACIDS.

The quantity of fatty acid present in the soap is an eloquent index of its quality. According to Lewkowitsch, pure commercial soap should contain 60—64 per cent fatty acid. Consumers sometimes insist on the presence of 75 to 80 per cent of fatty acids in soaps, and in such cases an analysis will be necessary to test if the finished product fulfils the required conditions.

To ascertain the percentage of fatty acid present, first dissolve a measured quantity of soap, say 5 to 10 gr., in about 250 c.c. of distilled water, warm the solution, add a few drops of methyl orange, and then dilute hydrochloric acid until there is a slight excess of acid present. Heat the liquid in a tall beaker on a water bath until the fatty acids separate out as a thick oily layer and the liquid below is only slightly turbid. Cool and remove carefully the solidified cake of fatty acids with a spatula, rinse with cold water, and place on a filter paper. Carefully scrape off any small particles of fatty acids adhering to the sides of the beaker and add to the cake. Now dry the cake by touching lightly with a filter paper, transfer to a weighed dish and melt by heating in the steam oven for a few minutes. If the melted fatty acids are observed to be free from moisture, they should be weighed in a desiccator and weighed. If however drops of water are observed on melting the cake, the fatty acids should be allowed to cool and the cake should again be dried with filter paper as described above. Now weigh the fatty acid, from which the percentage of fatty acid can be calculated.

In case the fatty acid is found to remain liquid or inconveniently pasty on cooling, this difficulty can be overcome by adding 5 grms. of shredded beeswax or paraffin wax to the mixture, and heating until the mixture of the fatty acids and wax has collected as a clear transparent layer. On cooling the cake is removed, washed and dried as before. To obtain the weight of fatty acids the weight of added wax must be deducted from that of the cake.

DETERMINATION OF SILICATE.

The solution obtained after the separation of fatty acids is evaporated to dryness with excess of hydrochloric acid. Add hot water to the residue, stir well, allow the solid to subside and decant the liquid through a filter. Wash the residue two or three times, filter, dry, and ignite. From the weight of silica thus formed the percentage of silicate can be calculated.

DETERMINATION OF FREE ALKALI.

5 grams of soap are dissolved in about 200 c.c. of hot water. Add methyl orange or cochineal as indica-

tor. Triturate with *N*/5 sulphuric acid. The fatty acids set at liberty have no action upon either of these indicators. Each c.c. of N/5 sulphuric acid required for trituration corresponds to ·008 grams of caustic soda or ·0112 grams of caustic potash.

If the amount of potash be required when potash and soda are present, a given weight of soap is decomposed with hydrochoric acid and the filtered solution treated with platinum chloride. The solution is evaporated nearly to dryness on a water bath. The solution should remain highly-coloured yellow during the whole of the evaporation. If it becomes colourless, or nearly so, more platinum chloride solution must be added. The dish is allowed to cool and a mixture of alcohol and ether added in order to dissolve the excess of platinum chloride and sodium salts present. After 10 to 15 minutes the liquid is decanted through a small filter, and the operation repeated 4 or 5 times, until the filtrate is not only colourless but also leaves no more than the slightest stain when a drop or two is evaporated on a watch-glass.

The precipitate is transferred to a small weighed platinum or porcelain basin. It is then dried in an air chamber and allowed to cool.

485 parts of the precipitate ($K_2 Pt Cl_6$) correspond to 138 part of potassium carbonate.

DETERMINATION OF FREE FAT.

Dissolve a weighed quantity of soap in water and shake the solution with ether in a separator. The free fat and unsaponified oils in the soap are absorbed by the ether. When the liquids have separated, the aqueous solution of soap is run off. The ether solution which contains the free fat is now washed with water and poured into a tared flask. The ether is now distilled and the residue dried and weighed. This is the unsaponified fats and oils in a dry condition.

For better results the aqueous solution of soap is shaken up a second time with ether and the operation is repeated. The residue is as before unsaponified fats and oils.

Now weigh the total quantity of unsaponified fat. From this the percentage of free fat can be computed.

DETECTION OF RESIN.

To detect the presence of resin in the soap, dissolve a very small quantity of the dried fatty acid in about 2 c.c. of acetic anhydride, in a dry test tube, heating gently if necessary. Cool the solution and add two or three drops of a cold mixture of equal volumes of glacial acetic acid and strong sulphuric acid. If there is a violet colour, resin is present.

DETERMINATION OF WATER IN SOAP.

A porcelain dish large enough to allow about 5 grams of soap being heated and stirred freely is weighed carefully along with a glass rod. A quantity of soap is placed on the soap and the whole weighed again. The difference of two weights gives the weight of the soap taken. As stated not more than 5 grams of soap are taken.

Heat in a water bath until the soap attains a constant weight. Loss of weight gives the quantity of water present in the soap whence the percentage of moisture in soap can be found out. During heating all votatile substances, e.g., ethereal oils used for scenting are expelled. Hence the loss in weight includes the volatile substances also.

There are other reasons why the percentage of moisture in soap is not accurate. Soaps lose a part of the water they originally contained on exposure to air, the extent of the loss depending both on the nature of the soap, the time and the conditions under which it has been kept. Again in case of the soap containing a considerable proportion of caustic soda, the soap absorbs a quantity of carbon dioxide, thus vitiating the true percentage of water in soap.

DETERMINATION OF CARBOLIC ACID.

Take about 100 grs. of the soap, dissolve in hot water and add sufficient caustic soda to make the solution strongly alkaline. Then salt out the soap by addition of salt, filter off the curdy soap and wash it with saturated brine. Concentrate the filtrate which contains the phenols and cresols as sodium phenoxides, and precipitate any soap still retained in the filtrate by the addition of more salt, fiter again, and concentrate the filtrate to a small bulk.

Transfer the solution to a stoppered graduated cylinder of 50 c.c. to 100 c.c. capacity, add sufficient salt so that some remains undissolved, and acidify with sulphuric acid. The volume of separated phenols is then read off and the number of c.c. multiplied by 1.05 may be taken as the number of grms. present. If greater accuracy is required the separated carbolic acid should be extracted by ether, the ether being distilled off on a water bath and the residue weighed.

DETERMINATION OF SODIUM CHLORIDE.

In case the total anhydrous soap is not to be determined, it will be more convenient to use the following method:—

Dissolve 5 grams of soap in 300 c.c. of water, boiling if necessary to effect solution. Add about 25 c.c. of a 20% of neutral chlorine free magnesium nitrate solution. Without cooling or filtering triturate with standard silver nitrate solution using potassium chromate as indicator and calculate the result to sodium chloride or potassium chloride as the character of the soap indicates.